VOLUME XVI October, 1926 NUMBER 4

[FOUNDED IN 1906 AS THE AMERICAN QUARTERLY OF ROENTGENOLOGY]

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Twenty-Eighth Annual Meeting

MONTREAL, CANADA—SEPTEMBER, 20, 21, 22 AND 23, 1927

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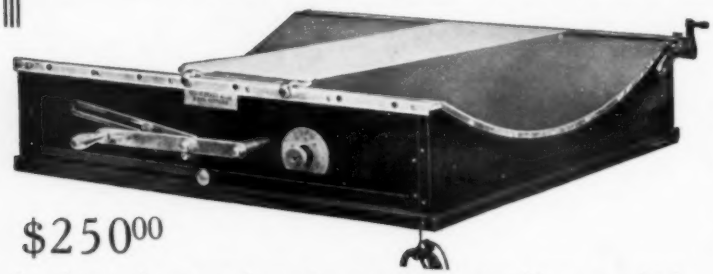

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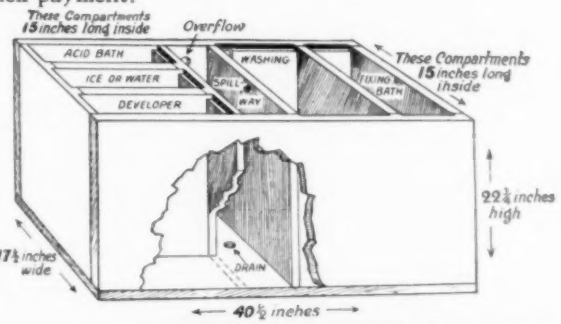

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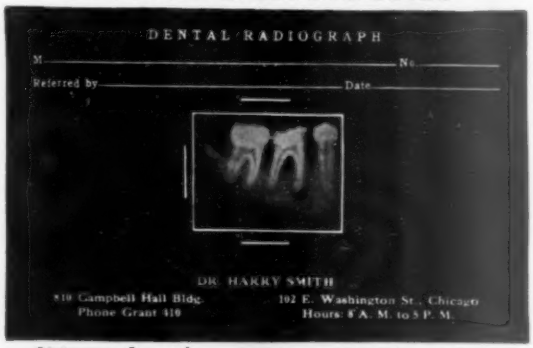

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XVI OCTOBER, 1926 No. 4

THE ROENTGENOLOGICAL DIAGNOSIS OF LIVER ABSCESS WITH OR WITHOUT SUBDIAPHRAGMATIC ABSCESS*

BY HENRY K. PANCOAST, M.D.

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PHILADELPHIA, PENNSYLVANIA

THE scope of roentgen-ray diagnosis has become so increasingly extensive in recent years that one is constantly wondering if we have not nearly reached the limit of conditions in which roentgenological study can be advantageously applied as a routine procedure. Certainly each new condition added to the list requires considerable labor, investigation and thought. Having had the opportunity to examine an unusual number of cases of hepatic abscess during the past three years, and having failed to render an exact diagnosis in many of them, we decided to institute a collective study of all of our new cases a few months ago, and included cases of many other conditions which presented similar appearances but introduced many confusing points in differential interpretation. As a result of this study, we believe that we have evolved a process of reasoning and interpretation which seems to make the diagnosis of liver abscess possible in most instances and to render the roentgen examination of value to the surgeon.

We have been inclined to regard the roentgen-ray diagnosis of subdiaphragmatic abscess as a comparatively simple matter ever since we were able to detect the condition at all. Hepatic abscess, on the other hand, has always seemed to be a very difficult condition to determine, until quite recently, when we began to understand its pathological aspect and its close relation with one type of subphrenic abscess. A correct history of the case is of paramount importance, and without it, we shall nearly always fail, for upon it must be based our diagnostic procedure and the interpretation of our findings. If we exclude the large number of cases of subdiaphragmatic abscess arising as a result of a more or less general peritonitis from various causes, such as visceral perforations, for example, perinephric abscess or following conditions above the diaphragm, as empyema necessitatis pointing through that structure, we have left subphrenic abscess secondary to liver abscess. In the type of cases particularly under discussion in this presentation and previously discussed by Dr. Eliason,[1] the important avenue of infection of the liver has been the portal circulation, or occasionally the biliary ducts (suppurative cholangitis). In these cases the roentgen diagnosis becomes a comparatively simple matter, provided we are familiar with the

[1] Eliason, E. L. Pylephlebitis and liver abscess following appendicitis. *Surg., Gynec. & Obst.*, April, 1926, xlii, 510–522.

*Read at the Twenty-seventh Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Detroit, Mich., May 17–21, 1926.

previous history. Indeed, with a correct history of the case, it is not essential that we attempt to separate the two conditions, but to regard hepatic abscess and subphrenic abscess as practically one and the same condition at different stages of progress.

It has seemed pertinent to depart from the usual manner of introducing a subject and to present the various cases as we have studied them and drawn our conclusions before discussing those conclusions in any general way. We have selected as our first case one of the older ones in which we failed completely in making a diagnosis and we shall point out as we proceed just where we erred in our interpretations. We failed in our primary diagnosis because two of the essential factors were lacking—familiarity with the condition and its pathology and a correct and complete knowledge of the clinical aspect of the case. The second case was one similar in all the essential details, and was studied at a later time when we could render a diagnosis.

Fig. 1. Case 1.

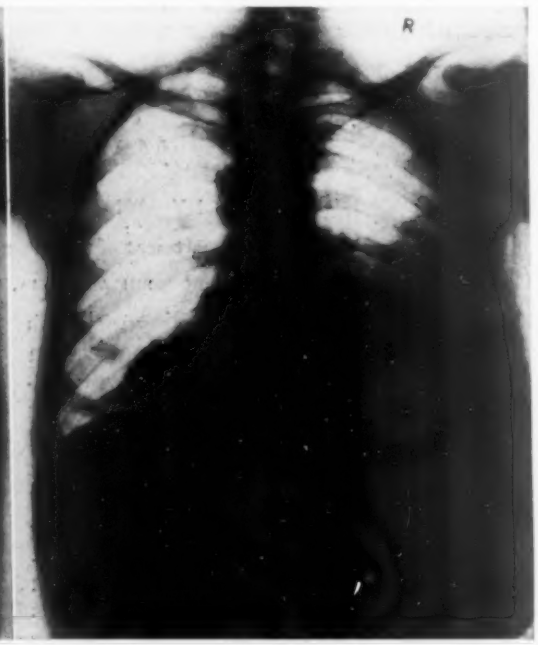

Fig. 2. Case 1.

Case 1. J. L. Male, aged thirty-four. About two years before admission an appendectomy was performed for an acute appendicitis, followed by drainage. He had suffered from abdominal pain ever since. Two subsequent operations were required for intestinal obstruction. He was admitted to the surgical ward of the University Hospital as a surgical abdomen, but was found to have lobar pneumonia and was transferred to the medical service for treatment of this condition. Three weeks later his temperature was normal but there were signs of consolidation or fluid at both bases. Our first examination was now made, August 23, 1923, with no knowledge of the previous clinical history except the pneumonia. We found (Fig. 1) a small quantity of fluid at the right base, probably localized, and what was regarded as delayed pneumonic resolution. The *right diaphragm was fixed and high*. We should have paid more attention to this, but in view of the only clinical data furnished, our thoughts were centered upon pneumonia alone, and we regarded the appearance of the right diaphragm as due to pleurisy and diaphragmatic adhesions. A small lesion at the left base was not identified.

Following this examination his temperature rose again and continued, septic in type, together with persistence of clinical signs of fluid at the right base. A little fluid was obtained by tapping after our first examination, but none afterwards. A second examination was made thirteen days after the first (Fig. 2),

and showed what was regarded as very definite evidence of a localized collection of fluid at the right base, but repeated taps were dry. The left base had now cleared.

A third examination was made thirteen days after the second, while the temperature was still up, and the blood examination showed no leucocytosis. We still thought there was a localized collection of fluid present. The diaphragm was still fixed and high (Fig. 3). Incidentally, we first learned at this time that the case had been admitted as a surgical abdomen, but even this knowledge did not attract our attention or suggest any cause for the diaphragmatic appearance other than pneumonia and pleurisy.

Four or five days later the patient was transferred back to the surgical service and was operated upon and a large subdiaphragmatic abscess was opened at a one stage operation, through the pleural cavity. This was found to communicate with a large liver abscess. Our fourth examination was made a week later and showed what we thought was a resulting pyopneumothorax but was said to have been only a hydropneumothroax (Fig. 4). Another examination made twenty-four days later (Fig. 5) showed the adherent high diaphragm and thickened pleura resulting from the operation and pleural involvement.

Evidently the increasing height of the diaphragm and the shadow above followed the rupture of the hepatic abscess. We should have diagnosed the subdiaphragmatic abscess at least, but our thoughts were centered upon a recent pneumonia and its supposed sequel, empyema. The error we regard as excusable because of lack of experience with liver abscess cases three years ago, the entire lack of any clinical data pointing to anything but the chest condition, and the resulting incomplete bedside examinations. The surgeon knew the past history of the case and saw it from the proper aspect, which was quite different from ours.

In the light of our present experience, we have good reason to believe that this patient did not have a true lobar pneumonia. In all of the roentgenograms made prior to the operation, there will be noted a haze above the elevated diaphragm which was regarded at different times as evidence of delayed resolution or fluid. It will be noted in connection with many of the cases of liver and subphrenic abscess referred to later on that a slight lung reaction above the diaphragm is described.

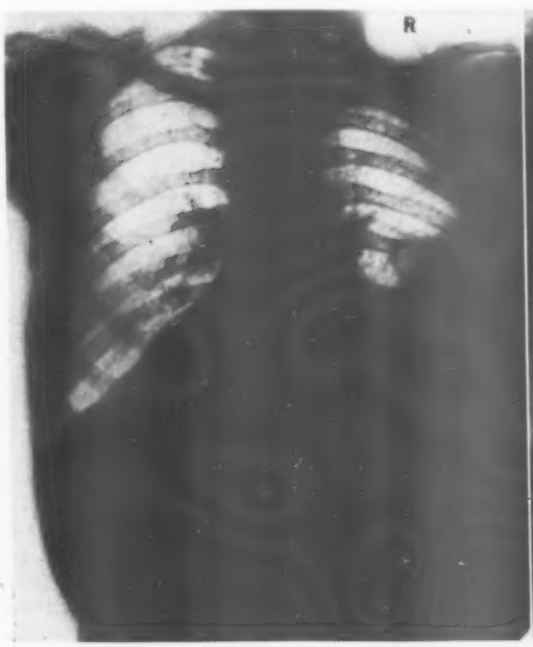

Fig. 3. Case 1.

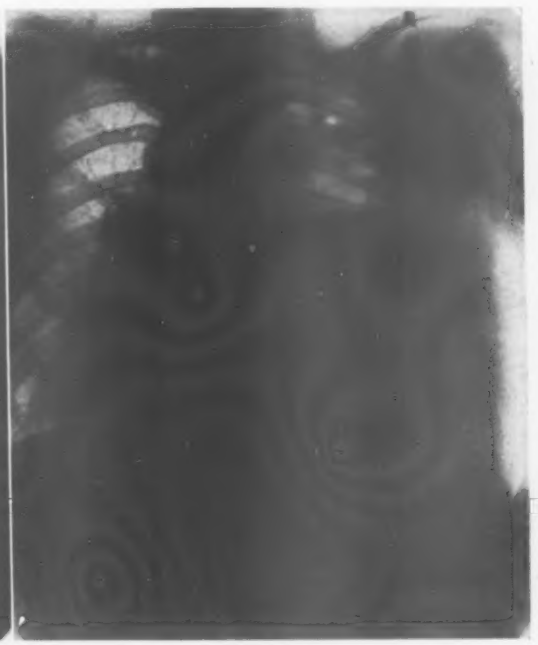

Fig. 4. Case 1.

This frequently depends, in the hepatic abscesses, upon the nearness of the lesion to the upper surface of the liver. We are inclined to believe that the supposed pneumonia in this case may have been an exaggerated lung reaction. This view is further substantiated by a study of the temperature chart (Fig. 6), which is certainly not that of a typical lobar pneumonia.

Similar conclusions will be found in connection with a supposed pneumonia

Fig. 5. Case 1.

encountered in Case 11, referred to us two years later, when our knowledge of the subject was becoming somewhat established as a result of the study of our entire group of cases. Fortunately that one came to us for examination directly from the surgical service, and with the surgeon's viewpoint more or less in evidence. Even though the two cases were not referred consecutively, it seems wise to group them together for purposes of comparison.

Case 11. A. J. W. Male, aged twenty-four. On November 4, 1925, he had a gangrenous appendix removed, and subsequently a fecal fistula developed. Eight days later he exhibited the symptoms of cough, shortness of breath and pain in the right chest; the temperature rose to a moderate degree (Fig. 7) and there was a dullness at the right base. The clinical diagnosis of the acute chest condition was massive atelectasis (so-called collapse) or pleural effusion at the right base, and for this he was referred for a bedside chest examination on November 14. Our diagnosis at first was massive atelectasis (Fig. 8), but we subsequently changed this to lobar pneumonia because we did not believe there was sufficient heart displacement for atelectasis, and no more than is frequently seen with the vertical heart in lobar pneumonia. It is true that the patient did not have the typical clinical picture of lobar pneumonia. On the other hand, the right base did not seem to clear up sufficiently fast for atelectasis, as shown by the second examination made six days later, November 20 (Fig. 9), and subsequently.

A third bedside examination (Fig. 10) was made eight days later and showed some decrease in the area of apparent consolidation. The patient had improved somewhat clinically but was still running a temperature of about 100°F. The right diaphragm was now becoming well differentiated and was high, but its movement was not studied. We at first suspected a pleural effusion, but on learning that Dr. Eliason suspected a portal system infection following operation in this case, we at once settled upon a diagnosis of a subdiaphragmatic condition, and were no longer misled by the supposed complicating pneumonia. Two days later, Dr. Eliason performed a thoracentesis at the tenth interspace and withdrew 120 c.c. of clear straw colored fluid. He was not sure whether this fluid came from above or below the diaphragm, but because of the marked clearing of the base shown by an examination the next day (Fig. 11), December 1, we were certain that it came from above. At any rate, the elevated diaphragm, found fixed on roentgenoscopy, settled the diagnosis of a subdiaphragmatic condition, either liver abscess alone or with subdiaphragmatic abscess. On coughing, the entire right diaphragm moved about half an inch, showing that it was not adherent.

A first stage operation was performed the same day, and at the second stage, three days later, December 4, a large liver abscess was opened through the transpleural route and drained. The patient made an almost uneventful recovery. A follow-up examination made January 30, 1926 (Fig. 12), showed the right diaphragm dome lower and adherent laterally, as would be expected after the operation. It moved slightly, except the outer portion. An area of density was observed, in the upper

portion of the right lower lobe (flat film made), the identity of which was uncertain. The appearance suggested a lung abscess, but the patient was clinically well and presented absolutely no clinical evidence of lung abscess. A later examination showed that the lesion had decreased in size and we concluded that it was probably a sterile infarct.

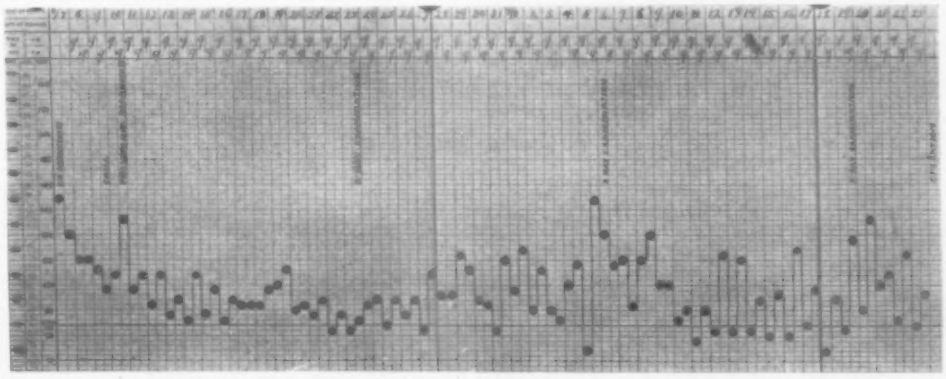

Fig. 6. Case 1.

At this point it seems pertinent to discuss the chest lesions of these two cases together. I suggested recently to Dr. Eliason that the apparent pneumonias in round any large abscess and that edema of the skin and subcutaneous tissue may overlie a liver abscess. It seems reasonable to suppose that a similar reaction could arise in lung tissue. Moreover, a moderate amount of clear fluid is frequently found in the pleural cavity, as in Case II. Dr. Eliason has quite agreed to this explanation of lung appearances and physical signs and symptoms and has suggested calling the lung reaction a pulmonitis.

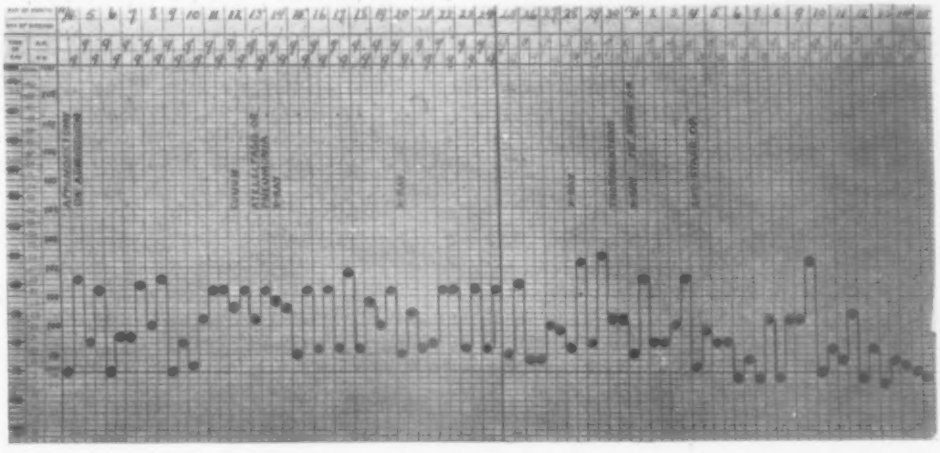

Fig. 7. Case II.

both of them were not pneumonias at all, but exaggerated lung reactions such as were noted to a much less degree in so many of the other cases. The temperature charts are not those of lobar pneumonia (Figs. 6 and 7). We know that extensive areas of congestion and edema may surround any large abscess and that edema of the skin and subcutaneous tissue may overlie a liver abscess. It seems reasonable to suppose that a similar reaction could arise in lung tissue. Moreover, a moderate amount of clear fluid is frequently found in the pleural cavity, as in Case II. Dr. Eliason has quite agreed to this explanation of lung appearances and physical signs and symptoms and has suggested calling the lung reaction a pulmonitis.

While the clinical signs and facies in these two foregoing cases were similar to those of pneumonia, there was no bloody expectoration, less cough and a lower and more irregular temperature. Certainly the temperature was due in a measure, at least, to the infection in the portal system and

liver. Because Case II did not present a true clinical picture of pneumonia, the internist diagnosed the condition massive atelectasis.

Case III. A. H. Male, aged twenty-two. He was referred to us for roentgen-ray examination October 31, 1924, from the medical service of the University Hospital with the rather incomplete history of recurring attacks of abdominal pain for ten months, extreme emaciation with loss of over 100 pounds, a cough with little expectoration for six weeks

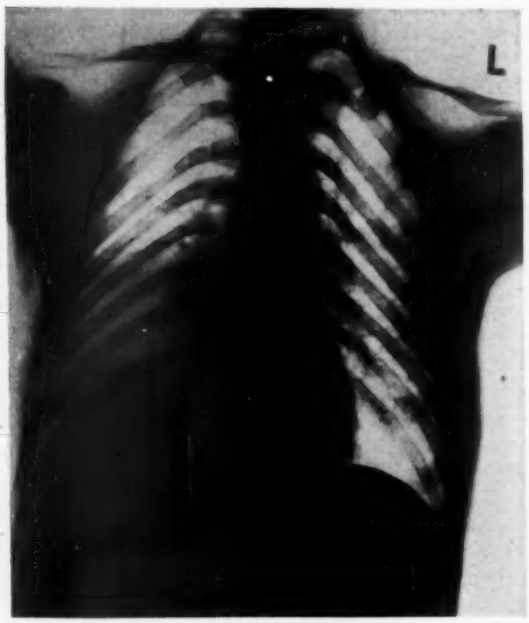

Fig. 8. Case II.

and a mass in the right upper abdomen. There were no chest signs at the bases. The bedside examination (Fig. 13) showed a high *left* diaphragm. No roentgenoscopic study was made. As there was nothing found above the dome of the diaphragm to account for its elevation, we interpreted an inflammatory condition below. In the roentgenogram we found two shadows, the upper one of which we regarded as the diaphragm dome and the lower one as the edge of the left lobe of the liver. A subdiaphragmatic abscess between was the final interpretation. This was not reached at the first operation because a right paramedian incision was made on account of the presence of the right upper abdominal mass. Exploration disclosed a large liver. Pus was withdrawn through a needle introduced into it and a small abscess of the liver was opened. Further exploration revealed three or four more pockets of pus. Adhesions were felt between the left lobe of the liver and the left diaphragm, but none were found on the right side. Numerous other small abscesses were palpated throughout the liver. A surgical diagnosis was made of diffuse suppurative hepatitis of portal origin. This patient had had no previous operation, but an attack of appendicitis was surmised. A subsequent two-stage operation was performed on the *left* side on the basis of our roentgen-ray findings. At the first stage, after resection of the tenth rib, the left diaphragm was attached to the lateral chest wall, and at the second stage procedure, a large subdiaphragmatic abscess was opened and about a pint of pus evacuated. Our second examination (Fig. 14), November 14, showed the left diaphragm attached to the lateral chest wall and a large subdiaphragmatic cavity between it and the liver. The patient subsequently died and the multiple liver abscess origin of the subdiaphragmatic abscess was confirmed at autopsy.

The diagnosis of a subphrenic abscess in this case was very readily made, but through lack of knowledge of the condition and its pathology and lack of experience with its roentgenological signs at that time, it is probable that we would not have been able to diagnose a liver abscess had we examined the patient at an earlier stage.

Case IV. M. A. Male, Greek, aged twenty-six. He was referred to us for a chest examination with a history that within two or three days after an operation for common duct obstruction and jaundice, he developed a cough, slight dyspnea, fever and a hectic flush. Pneumonia or postoperative pulmonitis was suspected. Our bedside examination made May 4, 1925, showed what was thought to be a postoperative central pneumonia at the right base. The right diaphragm was somewhat elevated, but we attributed this to the lung lesion. No roentgenoscopic study was made. A second bedside examination three days later showed that the area of lung involvement had spread considerably, and it now gave rise to definite physical signs of pneumonia. A third examination nine days later, when the patient was fever free, but signs still persisted, showed that the right base was clearing. After four or five days of freedom from fever, the patient was permitted to sit up in a chair, but suddenly developed a cough and pain in the chest, and the temperature again rose. Râles and dullness

at the base had persisted. The conditions under suspicion clinically were pleurisy with effusion, liver abscess from ascending biliary infection and subdiaphragmatic abscess. A fourth roentgen-ray examination, May 23, 1925, showed the right base to be fairly clear, but the right diaphragm was high and restricted in movement (Fig. 15). The presence of some movement was regarded as eliminating subdiaphragmatic abscess. Our knowledge of liver abscess and our experience in its diagnosis were still undeveloped, and we connected the high restricted diaphragm with the supposed preceding pneumonia and not with the previous operative history and a possible liver abscess, which we would certainly do now. The patient was operated upon by Dr. Eliason, with resection of the ninth rib, and a large hydatid cyst of the liver was found, containing 8 or 10 ounces of thick creamy pus and numerous jelly-like cysts. A subsequent examination made June 12, showed the diaphragm fixed as a result of the operation, and the cyst cavity in the liver with a fluid level. The patient made a complete recovery.

We could not, of course, have diagnosed a hydatid cyst in this case, but in view of the history and the roentgen-ray findings after the subsidence of a supposed pneumonia, we would certainly diagnose a liver abscess now, with our present experience, and would be nearer correct than we were at the time. In this case the lung condition may have been a true pneumonia, or possibly it may have been a lung reaction to a cholangitis, although this hardly seems likely. It was not, of course, a lung reaction to a liver abscess.

Case v. K. E. Male, aged forty-five. This case is cited next in order to compare it with the preceding one. The patient was referred to us for a chest examination October 13, 1924, without any history except that he had been on a prolonged trip to the Near East, and returned about six weeks previous to his visit to us, complaining of pain in his right chest and shoulder. He had lost considerable weight. There was a shifting area of dullness at the right base. Our examination showed clear lungs, but the dome of the right diaphragm was high and was fixed except just at its inner aspect. The liver was apparently very large. We considered two interpretations—elevation due to a large liver, or, because what appeared to be the dome of the diaphragm was very hazy, a diaphragmatic collection of fluid between the diaphragm and lung (Fig. 16). We recommended thoracentesis. This was done, and the needle entered an amebic abscess of the liver. We had eliminated a subdiaphragmatic abscess because the dome of the dia

Fig. 9. Case 11.

Fig. 10. Case 11.

phragm was not evenly elevated. We should have realized that a large liver alone would not fix the diaphragm (see Case VI). Dr. Eliason performed a two-stage operation, and opened the abscess and evacuated 350 c.c. of pus. Another examination, October 28, ten days after the first stage operation, showed a small abscess cavity still draining through the tube, and a third examination, one month later, showed nothing unusual except the adherent diaphragm resulting from the operation (Fig. 17). It was considerably more movable than at first.

Case VI. B. C. Female, aged twelve. This case came to us with a history of large heart, decompensation, large liver, due to passive congestion, and pleural effusion. The examination showed an enormous liver elevating the dome of the right diaphragm to a very high level. There was some fluid in the pleural cavity. The very high right diaphragm dome moved as freely on forced respiration as the left (Fig. 18). This case is cited to show that a large liver alone will elevate the diaphragm but will not interfere much with its movement. The shadow continuous with the right mediastinal border is a large right auricle.

Case VII. N. L. Male, aged forty. The clinical notes furnished with this patient stated that two and one-half months before admission he had an attack of acute appendicitis, from which he apparently recovered without operation. For two weeks he had been jaundiced and had a dull aching pain in the right hypochondrium. He was emaciated. The signs and symptomatology were suggestive of infective cholangitis with abscess. Roentgen study was requested to determine the size of the liver, the possibility of subdiaphragmatic abscess and any chest involvement. Our examination made March 5, 1923, showed a marked elevation and almost complete fixation of the right diaphragm probably due to subdiaphragmatic or liver abscess (Fig. 19). The lungs were negative. At the present time we would probably have favored liver abscess to the exclusion of subdiaphragmatic abscess because some movement was still found in the diaphragm. Upper abdominal peritonitis would restrict but not elevate the diaphragm to the extent observed in this case.

At operation the following day, the liver was found enlarged, but not adherent to the diaphragm. An enlarged gall-bladder was opened and found to contain thick bile. Pus came through the cystic duct on probing. The surgical diagnosis was suppurative cholangitis and liver abscess due to pylephlebitis following acute appendicitis. The patient died and autopsy revealed one large liver abscess and many smaller ones. Dr. Eliason believes that the discharge of pus into the cystic duct was due to the liver abscess.

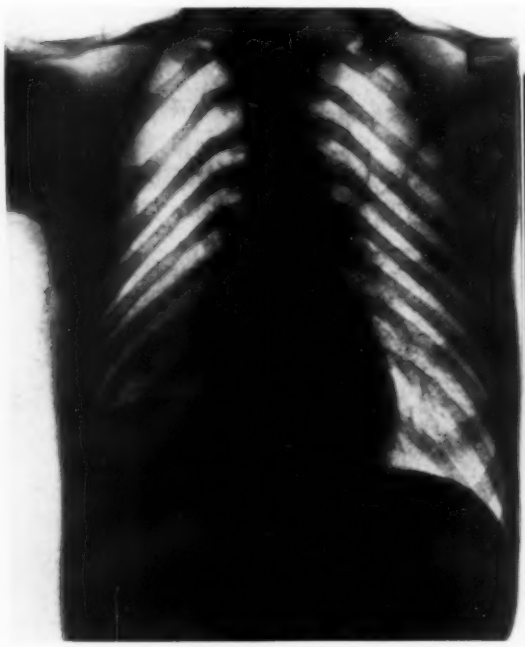

Fig. 11. Case II.

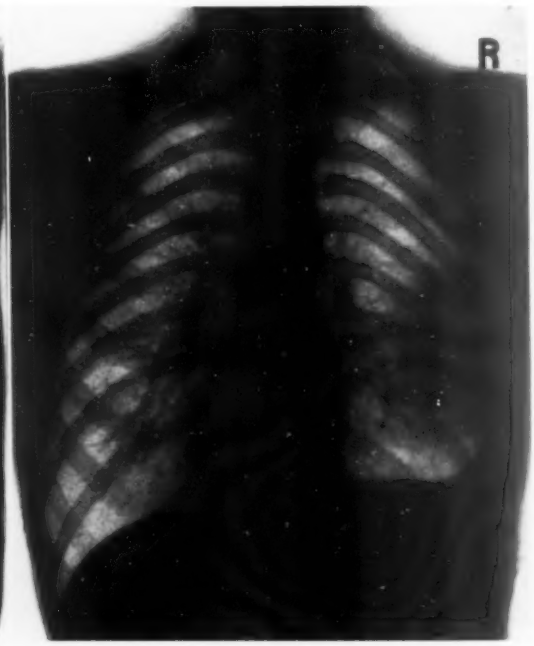

Fig. 12. Case II.

Case viii. V. H. Female, aged thirty. This patient had a gall-bladder operation two years before, and a second operation for common duct obstruction was performed by Dr. Müller, February 18, 1926, followed by a very stormy convalescence, during which she nearly died. She then improved and her general condition was very good until five days before we saw her, when she developed a temperature of 103°F. and a cough. Râles and impaired percussion were found at the bases. Pneumonia or subdiaphragmatic abscess was suspected.

Our first examination made March 25 showed marked restriction of the right diaphragm. The lungs were entirely clear but there was a very noticeable enlargement of the tracheobronchial lymph nodes. In view of the history, the diaphragmatic restriction was obviously due to one of four conditions—cholangitis, liver abscess, high peritonitis or subdiaphragmatic abscess. The last was excluded because the diaphragm showed little if any elevation and moved slightly. The reflex effect of operation was excluded as the time interval was too long. The other possibilities remained in doubt and serial studies were recommended. A second examination made March 27 showed that the lymph node enlargement had increased but the lungs were still clear (Fig. 20). The dome of the right diaphram showed almost no movement but was not elevated. Any of the three doubtful conditions seemed still possible, and a careful watch for localizing signs was advised. The temperature was still high. A few days later the patient suddenly recovered and insisted upon going home. We then concluded that the cause of the diaphragmatic restriction was possibly cholangitis, although we are not certain this assumption is correct in view of the long time interval after operation. We ascribed the fever, lymph node enlargement and sudden recovery to the epidemic of influenza then prevalent.

Fig. 13. Case iii.

Fig. 14. Case iii.

This case is cited to show the watchful care necessary in the study of a possibly developing liver abscess and the similarity in phenomena that may be exhibited by another condition.

Case ix. F. M. Male, aged thirteen. This patient was operated upon July 31, 1924, for an acute perforated appendix with resulting diffuse peritonitis. Thirteen days later he was well enough to sit up in a chair for a short time. His temperature then rose to 104°F. Three days later, August 16, a chest examination was negative for pneumonia or subdiaphragmatic abscess. A second examination two days later (Fig. 21) showed a slightly elevated right diaphragm restricted at its outer half, a slight effusion in the costophrenic

sulcus and a shadow in the right lower lobe which we would now recognize as a lung reaction. Again we did not diagnose the exact condition present as we were not familiar with it. Dr. Eliason operated August 20. A needle introduced into the pleural cavity brought no fluid, but introduction lower down revealed pus. After resection of the tenth rib, a liver abscess was found near the upper surface and was opened and drained. The patient made a complete recovery. A follow-up examination made March 14, 1925, showed only a slightly restricted right diaphragm.

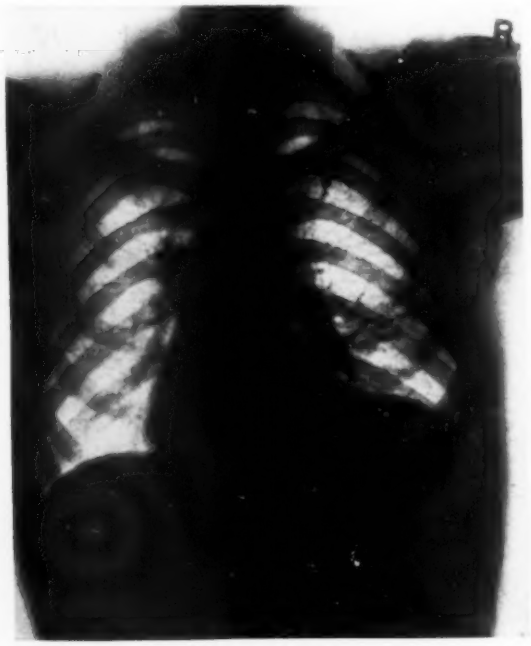

Fig. 15. Case iv.

This was a typical case for roentgen-ray diagnosis, and the condition could be readily recognized now. It was not recognized at the time because of lack of familiarity with the condition and its roentgenological features. The essential clinical facts were forthcoming and all of the signs were present. It is an interesting case in showing the exact time of onset of roentgen-ray evidences. There were no signs present on the sixteenth day after operation or third day after onset of symptoms, but two days later the elevation and restriction of the diaphragm, the lung reaction and a slight effusion were all present. Probably the nearness of the abscess to the upper surface of the liver was responsible for the short interval between onset of symptoms and complete roentgen-ray signs.

Case x. E. G. F. Female aged sixty-seven, was referred for a chest examination with the following brief clinical data: Four weeks previously she was operated upon by Dr. F. E. Keene for a localized appendicial abscess. She had a favorable convalescence until eight days later, when her temperature rose from normal to 100.3°F. and continued up as high as 102.2°F. On the eighteenth day a typical lobar pneumonia was diagnosed clinically. We made a bedside examination without roentgenoscopy, December 23, 1924, on the twenty-fourth day, and found a very high right diaphragm, which we regarded as indicative of a subdiaphragmatic abscess. The next day Dr. Eliason diagnosed a liver abscess and operated on December 26. Through the region of the resected tenth rib he introduced a needle through the diaphragm and withdrew pus. A large subdiaphragmatic abscess was then opened and was found to communicate with a liver abscess. The patient made a complete recovery.

This was an old case and was not thoroughly studied roentgenologically. Nevertheless, we would probably make the same diagnosis of subdiaphragmatic abscess at the present time, because when both conditions are present the signs of subphrenic abscess predominate. It is quite likely that the supposed pneumonia was only a lung reaction as in Cases i and ii.

Case xi. F. W. Male, aged twenty-five. This patient was operated upon by Dr. Eliason for acute appendicitis January 27, 1926. As he developed a postoperative temperature of 100°F. and a productive cough, he was, according to our mutually arranged custom, referred for a bedside roentgen-ray examination on February 1. The film showed a slight haze at the left base, but insufficient in extent to draw any conclusions except to suspect a slight pulmonitis such as we have so frequently found under similar circumstances. He recovered fully and was discharged on February 19. A few days later he developed pain in the right lumbar region and chills. He was readmitted on the medical service with a temperature running about 101°F. and a leucocyte count of 18,000. He was referred March 1 for an examination for possible subdiaphragmatic abscess. Our examination revealed a slight elevation and slight restriction of the right diaphragm with clear lung above. This, with the previous

history, strongly suggested some condition below the diaphragm, either high peritonitis below the liver or beginning liver abscess, but not subdiaphragmatic abscess. We advised further serial study. The next examination made March 4, after the temperature had risen to 102°F., revealed somewhat greater restriction of the right diaphragm, the maximum movement of the dome on forced inspiration being three-eighths of an inch. The elevation was the same as before (Fig. 22). There was still no lung reaction.

The exact diagnosis was still somewhat uncertain between the two conditions above stated, but we felt justified in advising Dr. Eliason to be on the watch for the first evidence of localizing symptoms or signs. The next day the patient developed local tenderness and Dr. Eliason operated and found an abscess in the lower posterior edge of the liver.

This was one of our most recent cases and was carefully studied on the basis of our experience. The onset of symptoms was about one month after operation for acute appendicitis, and a few days after this onset the roentgen-ray examination showed suspicious early signs of the condition. There was no lung reaction, probably because the abscess was so far from the diaphragm. It is gratifying to know that a diagnosis is possible in liver abscess as far from the diaphragm as it can be.

One of the easiest diagnoses the roentgenologist is called upon to make is that of subdiaphragmatic abscess when air or gas is present in addition to the pus, provided the examination is carried out properly. The condition may be overlooked if the ordinary flat film bedside examination alone is made. Our experience has taught us that this procedure may be quite useless in any subdiaphragmatic examinations.

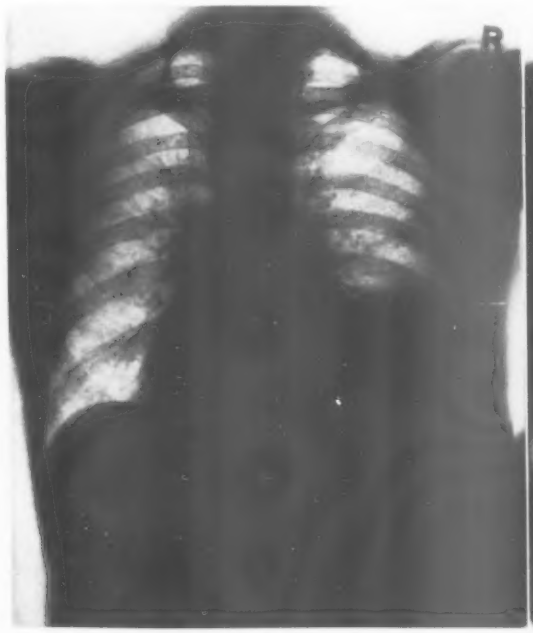

FIG. 16. Case v.

FIG. 17. Case v.

The following case is a good example of the ease of diagnosis in a case such as has just been mentioned.

CASE XII. M. B. Male, aged sixty-six. Dr. Eliason performed a cholecystotomy, and an infected gall-bladder was found, with muddy contents. The patient recovered and was discharged, but was readmitted December 16, 1925, about three weeks after the operation, complaining of severe pain at the operative site. At a second operation, December 21, an abscess was found at the site of the previous opening. Subsequently he became listless, ran a temperature of about 100°F. and developed a slight moderately productive cough. Liver or subdiaphragmatic abscess was suspected. A roentgenoscopic examination on December 28, made in the erect posture, showed at a

glance a subphrenic abscess with a fluid level and air or gas above it. The right diaphragm shaking the patient a visualized succussion splash was readily observed. The appearance

Fig. 18. Case VI.

Fig. 19. Case VII.

Fig. 20. Case VIII.

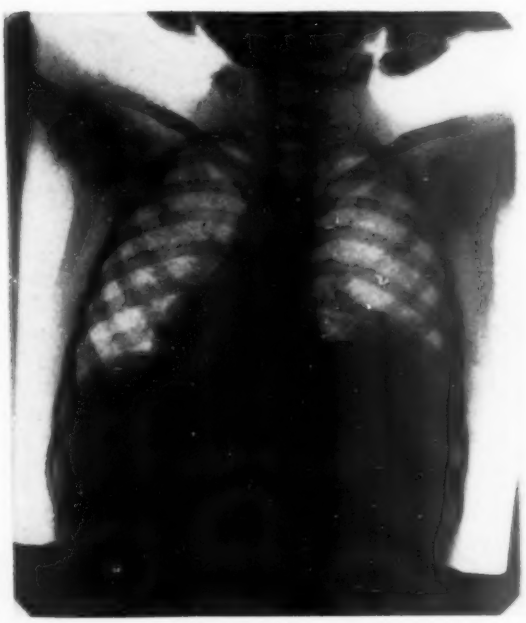

Fig. 21. Case IX.

was elevated and fixed, but moved on coughing, indicating that it was not adherent. On noted is well demonstrated in Figure 23. The lateral view is shown in Figure 24. The change in fluid level with the patient lying on

his left side is shown in Figure 25. He was operated upon at once, and a large subdiaphragmatic abscess containing about a liter of pus was opened and drained. No liver opening could be demonstrated, but could not be excluded. It was thought more likely, however, that the subdiaphragmatic abscess originated from an extension upward of the localized peritoneal infection around the gall-gladder region.

At the time of operation, the two pleural surfaces were found adherent; no first stage procedure was required and the pleural cavity was not entered. Unfortunately, when the operation was about completed, the patient coughed, stripped some of the adhesions and tore the pleura. This permitted some pus to enter the pleural cavity and caused an empyema for which examinations were made January 4, and January 12, 1926 (Fig. 26). The empyema was drained by a rib resection on January 13

A subsequent examination made February 4 (Fig. 27), showed no empyema, but there seemed to be considerable density in the base of the right lung. As the patient still had fever, we thought this indicated a lung abscess, but we finally concluded that the elevation in temperature was due to poor drainage and that the lung density was due to the combined effects of lung reaction and silicosis, which had been detected previously. The patient made a complete recovery.

Case xiii. Male, aged fifty. This patient was referred for examination to determine the condition at the base of the right chest, whether effusion, thickened pleura or subdiaphragmatic abscess. The liver was considerably enlarged. Our examination made December 14, 1923, showed a high irregular dome of the right diaphragm which moved freely, with the lung above it clear, indicating that the cause of the elevation was below the diaphragm, but not subphrenic or liver abscess. The costophrenic sulcus appeared only on deep inspiration (Fig. 28), because the hump was as wide as the right chest space with the diaphragm in all positions except low. A probable tumor of the liver was diagnosed until it was learned that the Wassermann reaction was strongly positive. We then regarded the condition as a probable gumma. A subsequent examination, March 4, 1924, after antispecific treatment showed that the hump in the dome of the right diaphragm had disappeared and there was only very slight restriction in movement (Fig. 29). This would seem to confirm the previous diagnosis of gumma.

Case xiv. Male, aged fifty-one. This patient was referred for a routine chest examination January 19, 1926. The lungs were negative, but there was an unusual elevation of the middle of the dome of the right diaphragm, which was restricted to about one-half the movement of the left (Fig. 30). The abrupt localized elevation was best shown in the oblique view (Fig. 31). Three conditions were considered, awaiting additional clinical data—liver abscess, echinococcus cyst and gumma. Tumor was not considered because of the moderately restricted movement. Abscess was excluded because of the lack of sufficient cause. When it was learned that the Wassermann reaction was strongly positive, we selected the diagnosis of gumma.

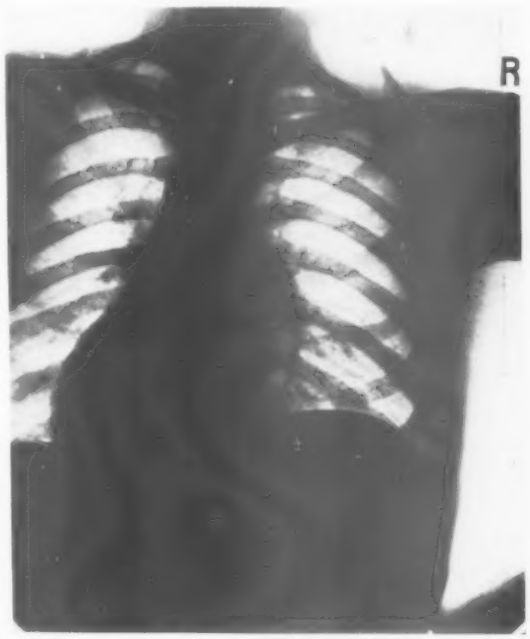

Fig. 22. Case xi.

This case is similar to the preceding one, but is cited because it demonstrates the value of lateral studies of the diaphragm, which we have learned by experience should always be made. It also shows that a gumma may cause some but not marked restriction of diaphragmatic movement.

Case xv. E. D. Female, aged forty-five. This case was referred for examination because of suspected pulmonary tuberculosis. Our examination on September 24, 1925 showed no lung lesions, but the dome of the right diaphragm was very high and freely movable (Fig. 32). As the patient had had her right breast removed for carcinoma ten years before, and

received postoperative radiation treatment, we inferred that the high movable diaphragm was due to metastasis to the liver.

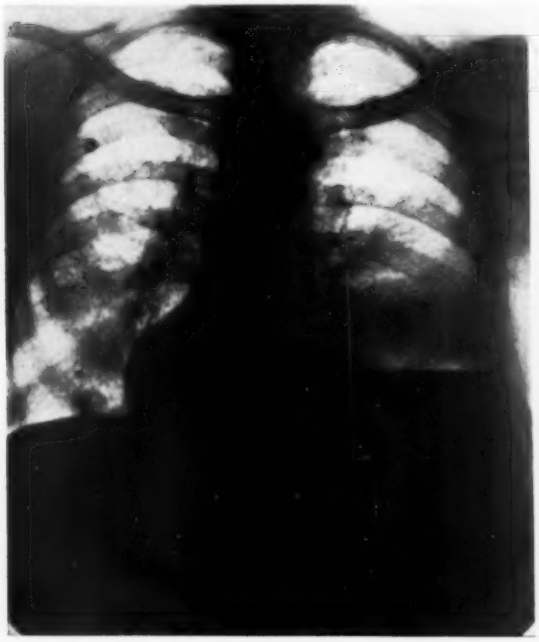

Fig. 23. Case xii.

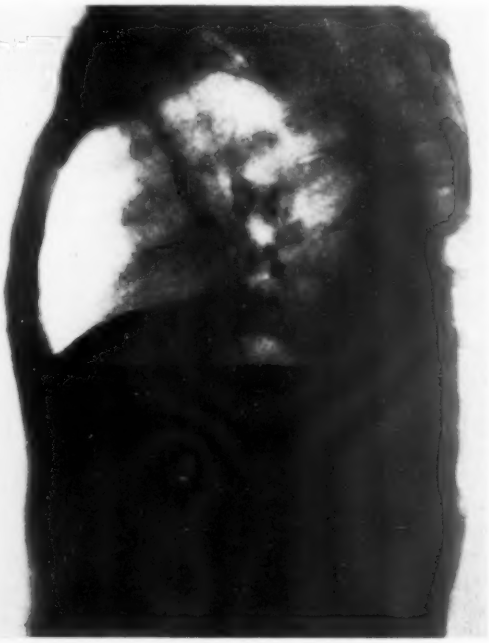

Fig. 24. Case xii.

Fig. 25. Case xii.

Fig. 26. Case xii.

This case is cited for the purpose of comparing the findings in tumor with those in gumma and abscess.

Case xvi. E. A. Female, aged fifty-two. The patient was operated upon six months before for gallstones, and the gall-bladder was removed. Pain was relieved but jaundice and clay colored stools continued. There was a mass in the right upper abdomen. Our examination made on August 5, 1925, showed a very high dome of the right diaphragm. Although there was almost complete fixation,

a diagnosis of liver neoplasm was made at the time. Fixation would seem most unusual to us now, but was explained at operation, when a large tumor mass was found protruding from the upper surface of the liver. The liver and diaphragm were adherent, hence the lack of movability of the latter.

This case is cited for the reason that, while somewhat similar to the preceding one, the unusual feature of adhesions made the interpretation of appearances difficult and uncertain.

COMMENT

The mortality in abscess of the liver and secondary subdiaphragmatic abscess has been high, and any assistance that can be rendered by roentgen-ray investigation toward an early diagnosis is of the utmost importance. The study of a fairly large group of cases of this kind and of other cases in which similar roentgenological phenomena were encountered, has convinced us that roentgen-ray studies may play a very important part in early diagnosis, provided certain general principles are observed. Without careful attention to the details of all of these principles, our investigations can be of little or no value and may be very misleading. We have not included in this report the entire group of cases examined, but only those in which roentgen-ray studies have been of material value in diagnosis, or those in which we have profited by our mistakes. The following essential principles must always be carefully considered:

1. A correct clinical history of the case is of paramount importance before beginning our investigations, and especially before attempting to make interpretations of our findings, or to draw conclusions.

2. A knowledge of the pathology of liver abscess is necessary in order to apply the clinical data. This subject is fully covered in Dr. Eliason's paper on the subject.

3. Correct technique of the examination. This must be worked out on the basis of the first two principles. Roentgenoscopy is absolutely essential, for by it alone can the diaphragmatic movement be studied. The erect posture is highly desirable, but if this is neither safe nor possible, the patient should be lifted from bed to the horizontal roentgenoscopic table. The modern tilt table will make the erect posture examination safe in most instances. A simple canvas stretcher is a convenient and safe device. Lateral views are usually instructive, especially in determining slight effusions and irregular elevations of the dome of the diaphragm. Single flat bedside films have little diagnostic value.

4. Correct interpretation is based upon the preceding principles together with a knowledge of other conditions which may simulate liver abscess from the roentgen-ray standpoint. This implies ability and knowledge sufficient to make a correct differential diagnosis.

Fig. 27. Case XII.

5. The roentgen-ray examination must form an integral part of the whole diagnostic procedure. Diagnoses cannot be made correctly on the roentgen-ray examination alone.

Roentgenological features of liver abscess are difficult to classify in a very concise manner because they are subject to so many variations. They are few in number but far more complex than they would seem at first glance. They may

be briefly enumerated as follows: (1) Elevation of the dome of the diaphragm, usually the right; (2) restricted movement; (3) absence of anything past or present above the diaphragm to account for these appearances, except a correctly interpreted lung reaction or small effusion; (4) the exclusion of numerous other conditions below the diaphragm. (5) Pneumoperitoneum might be of value in some instances, but we believe it is entirely unnecessary and would be impracticable

Fig. 28. Case XIII.

Fig. 29. Case XIII.

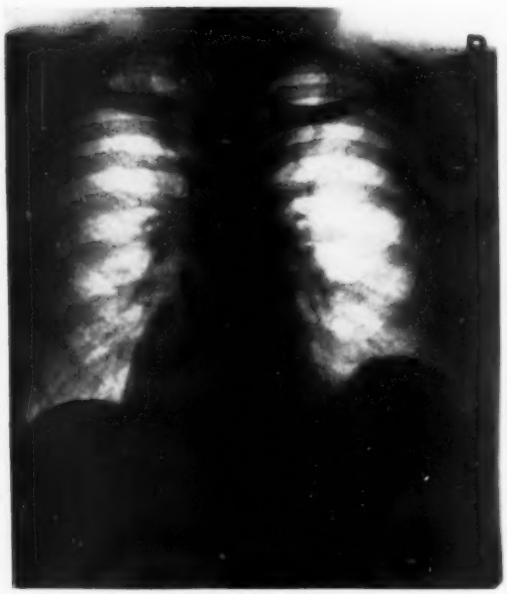

Fig. 30. Case XIV.

Fig. 31. Case XIV.

in serial study, which is so often required, and might be very dangerous. It will be dismissed with these remarks. It would certainly have been of no value in Case XI.

1. *Elevation of the Dome of the Diaphragm.* A diaphragm dome may give the impression of relative elevation to a certain extent under any circumstances under which the movement of the structure is interfered with. In liver abscess alone the elevation may be exceedingly slight, as in Case XI, to very high, as in Case VII. Elevation will depend largely upon the size of the abscess and its nearness to the upper surface of the liver. A rather sudden increase in elevation in a case being serially studied may be a sign of rupture of the abscess under the diaphragm, as in Case I. Subdiaphragmatic abscess is apt to produce much greater elevation than hepatic abscess alone, and there is usually complete absence of movement. When both conditions are present, the former gives the predominant signs. The right diaphragm is naturally more often affected because the greater part of the liver is on that side.

2. *Restricted Movement.* One diaphragm is almost invariably involved. The various causes of restriction of diaphragmatic movement are exceedingly numerous. Most of them are found in the thoracic cavity and will be excluded from discussion, as practically only pneumonia and pleural effusions and empyemas are likely to cause confusion. Liver abscess will always restrict movement no matter where located. Size and nearness to the upper surface almost always determine the degree of restriction. We usually regard subdiaphragmatic abscess as causing fixation or, a better term, complete absence of direct movement. We have been studying the effect of coughing as a determining factor between conditions above and below the diaphragm. The dome will always move slightly on coughing in liver abscess and perirenal abscess. We believe that it will not do so, or at least not perceptibly, in certain intrathoracic conditions, as basal empyemas or diaphragmatic pleurisy with effusion or in case of a very rigidly adherent diaphragm.

The development period of liver abscess is variable, and the time at which restriction will be noted is uncertain. In Case IX no signs of restriction were found sixteen days after appendectomy or three days after the onset of symptoms, but all roentgen-ray signs were demonstrable eighteen days after operation, or five days after the onset of symptoms. This is probably as early as any signs are likely to be detected, but is presumably past the time when operative trauma is likely to be confusing. Case XI also showed evi-

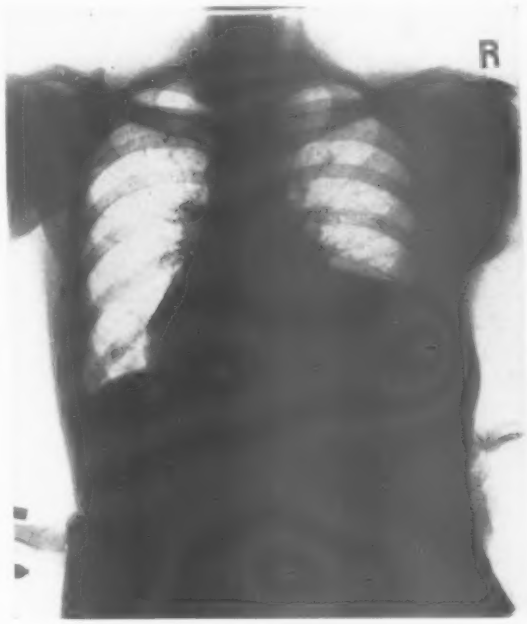

FIG. 32. Case XV.

dences of abscess very soon after the onset of symptoms.

3. *Lung Reaction.* This is not a constant finding but is very frequently encountered and may be a most confusing manifestation. It has led to a diagnosis of pneumonia in several instances, notably Cases I and II. A possible explanation for its appearance has already been alluded to. It is probably more likely to be found in connection with liver abscesses near the upper surface. It may be accompanied by slight pleural effusion, as in Case IX and others, and when fluid is present, the diagnosis may be simplified by its withdrawal. The exact time of onset of the reaction is uncertain, but in Case IX it

appeared simultaneously with the diaphragmatic restriction. In Case XI there was no reaction, probably because the abscess was so far from the diaphragm.

Intrathoracic conditions can, as a rule, be eliminated by careful consideration of the clinical aspect of the case. Probably localized diaphragmatic and central pleural effusions or empyemas and pneumonia are the conditions most likely to cause confusion. In diaphragmatic pleurisies the upper surface of the effusion may be mistaken for the diaphragm and the slight lung compression haze for a reaction. In one instance, without knowing the exact history of the case, we mistook a diaphragmatic empyema necessitatis rupturing through the diaphragm for an abscess of the liver causing subdiaphragmatic abscess.

4. *Subdiaphragmatic Conditions Complicating the Picture of Liver Abscess.* Operative trauma, especially in upper abdominal operations, will cause reflex restriction in movement. Just how long this will last, we do not know, but at present we are studying a series of postoperative cases roentgenoscopically in order to determine the approximate time. We do not believe it will prove to be long, possibly only one to three days.

Non-suppurative cholangitis will restrict diaphragmatic movement and possibly cause elevation for a variable time. There can be no definite time period because we do not know how long the condition will last. Case VIII was supposedly one of this nature.

Perirenal abscess and acute localized or more general peritonitis will cause restriction of diaphragmatic movement even when the area of involvement is not directly below the diaphragm. Very careful clinical study of the case is necessary in differentiating these conditions from liver abscess, as otherwise no differentiation will be possible. In all instances of suspected liver abscess, serial studies must be carried out until the diagnosis seems proven.

Gumma of the liver does not seem to restrict diaphragmatic movement very markedly. In one case there was no interference and in another the excursion was limited about 50 per cent. Tumors and other causes of hepatic enlargement cause little or no restriction. Both tumors and gummata localized near the upper surface are apt to produce irregular humping which is more readily detected in the lateral view.

The diagnosis of hydatid cyst of the liver (Case IV) and amebic abscess (Case V) is likely to be difficult, particularly as the history of the case is often indefinite. But even so, we believe a correct diagnosis is not impossible.

VOL. XVI, No. 4

ROENTGENOGRAPHY OF THE CAVITY OF THE UTERUS AND FALLOPIAN TUBES, WITH SPECIAL REFERENCE TO ITS VALUE IN CASES OF STERILITY*

BY

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INTRODUCTION

ROENTGENOGRAPHY of the cavity of the uterus and fallopian tubes had its inception in the pioneer work of Cary[1] in 1914. Cary used a solution of collargol as the opaque medium for this purpose. His work was followed by Rubin[2] in 1915 and Dartigues and Dimier[3] in 1916. In 1923, Kennedy[7] employed a 10 per cent solution of sodium bromid and in 1925, Tussau[4] and Mocquot[5, 6] used a suspension of bismuth for demonstrating the shape of the cavity of the uterus and the presence of fibroids. None of the solutions was entirely satisfactory and the procedure had little practical value until the advent of iodized oil. Lipoidol was introduced by Forestier and Sicard, [8, 9, 10] in 1923 in roentgenography of the bronchi and spinal canal and its use in gynecological roentgenography suggested. Since that time, a number of articles have appeared in the European journals, although in America the procedure is little known and its value not appreciated. Reports by Busson and Portret,[11] Heuser,[12, 13] Vercesi,[14] Ferré,[15] Gregoire, Béclère and Darbois,[16] Schober[18] and Forsdike[19] testify to the value of the use of lipiodol in roentgenography of the cavity of the uterus and tubes and to the harmlessness of the procedure.

Lipiodol is an iodized oil containing 0.54 gram of iodin to the cubic centimeter. The heavy iodin content makes the solution very resistant to the passage of roentgen rays. This is essential to the successful demonstration of such fine lumina as the isthmus or a constricted portion of the fallopian tube. The oily solution is sufficiently fluid to penetrate readily into very minute cavities and sufficiently cohesive not to be diffused too rapidly in the peritoneal cavity. It is antiseptic and absolutely free from irritating properties. Forsdike[19] is quoted as stating that lipiodol is absorbed from the peritoneal cavity in seven days. In the experience of the authors of this paper, the solution is never absorbed completely in that time but has been observed in considerable quantity in roentgenograms of the peritoneal cavity as long as nine weeks after instillation. In spite of the slowness of absorption, no instance of peritoneal irritation has been observed. No symptom of systemic effect due to absorption has been noted. Occasionally, the menstruation following injection is somewhat more profuse than normal although not advanced in time. This is probably due to the mechanical distention of the uterine cavity rather than to the properties of the solution. In the experience of the authors, the use of lipiodol in the cavity of the uterus, the fallopian tubes and the peritoneal cavity is effective, safe and simple.

TECHNIQUE

The technique of injection of lipiodol has been simplified as far as possible by the authors. The patient is prepared by an enema shortly before the test. She is placed in the lithotomy position on a cystoscopic table arranged for roentgenography. The cervix is exposed with a duck-bill speculum, the mucus removed and the cervix painted with tincture of iodin. A 5 c.c. syringe with an attached intrauterine cannula is used. A rubber "acorn" such as is used in the Rubin test is placed on the cannula with its base about 5 to 7 cm. from the tip. If the syringe and solution are slightly warmed, the oil flows more freely. A thin film of absorbent cotton moistened with water is wound around the "acorn." This

* From the Gynecological Service of Dr. G. Seeligmann and the Roentgenological Service of Dr. W. H. Stewart, Lenox Hill Hospital, New York City.

prevents the return flow of the oil into the vagina and obviates the necessity of using a volsella on the cervix either for traction or for clamping the cervix around the cannula, thus avoiding needless pain and trauma. The cannula is passed into the fundus of the uterus and the acorn pressed firmly against the cervix and held in that

Fig. 1.

Fig. 2.

Fig. 1. Normal shape and size of the uterine cavity. The tubes are normal and patent. Note the position of the cannula, the "acorn" and the wire loop placed in the posterior fornix of the vagina for purposes of orientation.
Fig. 2. Normal position, size and shape of the uterine cavity. The tubes are normal and patent.

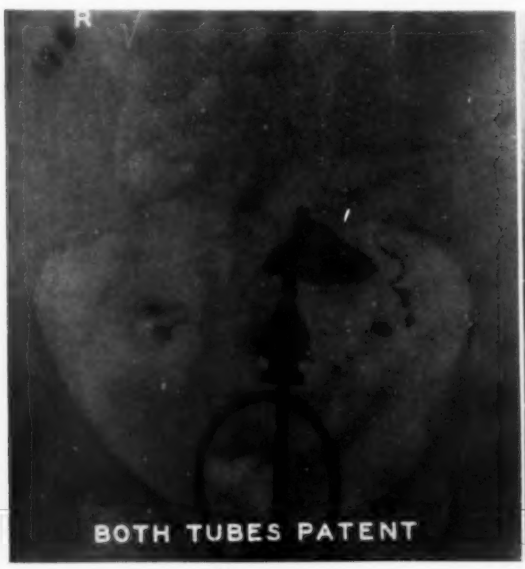

Fig. 3.

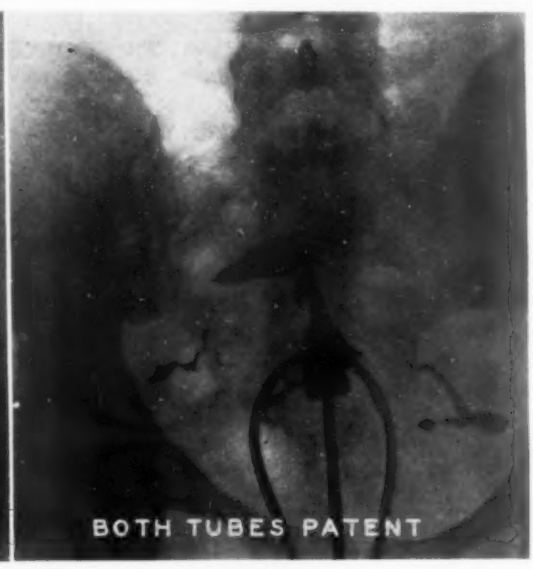

Fig. 4.

Fig. 3. Normal shape, size and position of the uterine cavity. The tubes are normal and patent.
Fig. 4. Normal size, shape and position of the uterine cavity. Tubes normal and patent.

position while the solution is injected and until the first pictures have been taken. Before injection, the speculum is removed and a wire loop placed behind the cervix in the posterior fornix of the vagina for purposes of orientation.

Five cubic centimeters of solution is injected into the cavity of the uterus with as little pressure as is necessary and as slowly as possible. The capacity of the average uterine cavity is about 1.5 to 2.5 c.c. but the cavity can easily be distended under pressure to hold 5 c.c. without danger to the uterus or tubes. The pressure exerted is sufficient to force the fluid through patent tubes so that a manometer for pressure reading is unnecessary. As will be shown later, the solution appears to pass into the tubes, at times, more readily under a low than under a higher pressure.

After taking the first stereoscopic roentgenograms suction is made with the syringe, removing as much of the solution as possible. Usually 3 or 4 c.c. can be removed. Another series of roentgenograms is now taken. The reason for this procedure will be explained later.

Roentgenoscopy performed while the solution is being injected is interesting as the progress of the oil in the uterine cavity and fallopian tubes can often be observed, but is of little practical value.

Stereograms are always taken and are considered essential to the accurate interpretation of the plates.

Roentgenograms are taken after the lapse of a considerable interval, twenty-four hours being considered a convenient time, to determine the presence of solution in the peritoneal cavity.

FIG. 5. Case of multiple fibromyoma of the uterus extending from the lower uterine segment as high as the umbilicus. Note the displacement of the cannula to the right side and the concave shape of the right side of the cavity of the uterus and its superior border due to the encroachment of fibroid nodules. The distortion is very slight compared with the large size of the tumor. The right tube was held by an adhesion at the point indicated by the arrow. Both tubes were patent.

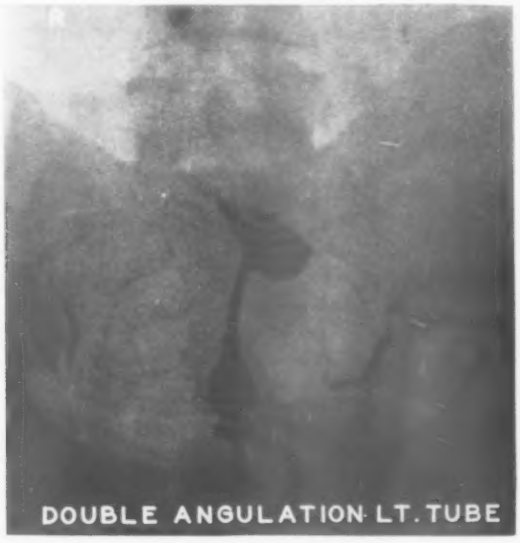

FIG. 6. The left tube is normal and patent. The apparent double angulation is an optical error. Examination with the stereoscope shows these apparent angles to be, in reality, curves. The right tube is occluded near the distal extremity.

INTERPRETATION OF THE ROENTGENOGRAMS

The shadow cast by the uterine cavity upon the plate shows the exact shape only when the plane of the cavity lies parallel to the plane of the plate. This condition occurs when the uterus lies in very slight retroversion (see Fig. 17). Deviations from this plane cause foreshortening with resultant changes in the shapes on the plates. If the cavity lies horizontally, the shapes shown in Figures 7, 11, 12 and 20 are produced. When very acutely anteflexed, the appearance of the shadow is as if the uterine cavity were inverted as shown in

Figures 3, 8, 10 and 28. It must be remembered that the shadow represents only the cavity of the uterus, the walls not being demonstrable. The size of the body of the uterus cannot be judged by the size of the cavity. The presence of fibromyomas is shown only when they distort the shape of the cavity. As shown by Figures 5, 16 and 41, roentgenography of the cavity of the uterus has very little, if any, value in determining the presence of fibromyomas. Stereoscopic examination is of the greatest value in determining the actual shape and position of the uterine cavity.

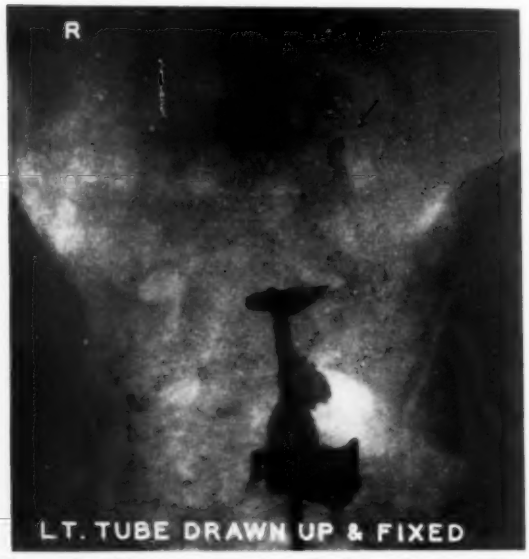

FIG. 7. In this roentgenogram, the left tube occupies a very unusual position. It extends upward out of the minor pelvis into the abdominal cavity. The small size of the uterine cavity corresponds to the findings of bimanual examination of a uterus of infantile type. Both tubes are patent.

The effects of projection may also cause some confusion in determining the actual conditions in the shape and position of the tubes. In Figure 1, the left tube and in Figure 13, the right tube appear to spring from the uterine cavity at a short distance from the fornices. In each case, the proximal portion of the tube casts its shadow within the shadow cast by the cavity and is concealed by it. A gentle curve in a tube, if lying in a nearly anteroposterior plane, may appear in the plate as a sharp angulation. Here, again, stereoscopic examination is of great value as the true conditions can be easily determined by this procedure. The left tube in Figure 6 and the right tube in Figure 16 are examples of this condition.

It must be strongly emphasized that the appearance of the shadows in any single roentgenogram may be insufficient for diagnosing the patency of a tube. It has been stated under Figures 11 and 12 that the tubes are occluded at the distal extremities. The appearance of the shadows would seem rather to indicate that the tubes are patent. Other sources of information must therefore be considered. In both cases, Rubin tests after several trials showed the tubes to be occluded. Stereoscopy showed that the solution was not diffused in the peritoneal cavity, and subsequent examination made twenty-four hours later showed the absence of solution in the peritoneal cavity. Lastly, the occlusion was proved at subsequent operation.

Another possible source of error in the diagnosis of patency of the tubes arises from the fact that in some cases the tubes fill very slowly and under changed conditions of pressure. Erroneous conclusions will be derived if a diagnosis is attempted by the observation of a single plate. Detailed consideration of 4 of the cases presented among the plates, will demonstrate the verity of this statement.

Case I: From the appearance of the left tube in Figure 28, the diagnosis of occlusion at the distal extremity would be made by an inexperienced observer, but Figure 29, taken twenty-four hours afterward, proves the patency of the tube by showing the presence of lipiodol in the peritoneal cavity.

Case II: In Figure 23, diagnosis of occlusion of the right tube at the isthmus would be made. Figure 24, taken ten minutes later after withdrawal of 4 c.c. of the 5 c.c. of solution injected, shows that the solution has penetrated through the isthmus into the lumen of the tube.

Case III: In Figure 25, the right tube would appear to be occluded near the distal extremity, but in Figure 26, taken about five minutes later after withdrawal of 4 c.c. of solution, it is seen that the lipiodol has passed farther into the tube. Even in this roentgenogram a diagnosis of occlusion at

the distal extremity might be made, but Figure 27, taken twenty-four hours later shows a large amount of solution in the peritoneal cavity, thereby proving the patency of the tube.

Case IV: In Figure 19, the lumen of the right tube appears occluded about an inch from the fundus, and in Figure 20, in the stereogram taken two minutes later without change in the conditions of intrauterine pressure, it is seen that the solution has passed farther into the tube. In Figure 21, after removing the cannula without withdrawing any solution, the lipiodol is seen to have passed through the entire length of the tube and is flowing into the peritoneal cavity and lastly, in Figure 22, taken forty-eight hours later, a large amount of solution is shown in the peritoneal cavity.

Although the tubes discussed in these 4 cases are patent, they are not considered normally patent by the authors. It will be noted that the cases are not normal as in each instance the tube of the opposite side is occluded at the isthmus. A number of theories may be advanced to explain the capricious manner of the filling of the tubes. A temporary valve action at the isthmus could be caused by distention of the uterine cavity which would explain the penetration of the isthmus by the solution after the increased intrauterine pressure is removed. Interest is aroused by the speculation of the possibility of a physiological mechanism for closing the isthmus to prevent intrauterine contents from entering the tubes. This closure might be effected by the contraction of the uterine walls or by contraction of the isthmus of the tube. The relation of such a mechanism to the function of the impregnation of the ovum and the question of sterility is of sufficient importance to justify careful observation and study. Contraction of the walls of the uterus upon the distended cavity, either through the elasticity or contractibility of the walls, may be the factor in the delayed filling of the tubes after the pressure caused by the injection is removed. Another factor to be considered is the condition of obstruction of the tubes

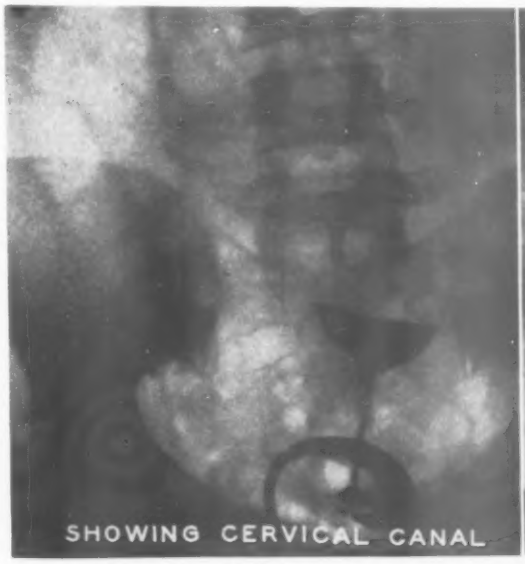

FIG. 8.

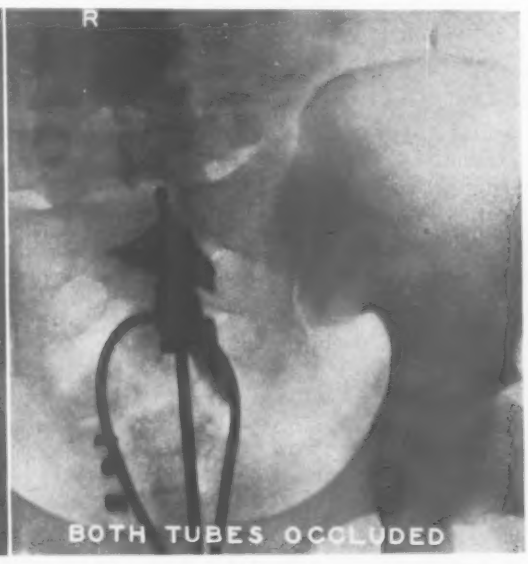

FIG. 9.

FIG. 8. Case of double subacute pyosalpinx. The cannula has been removed to show the cervical canal. The solution can be seen at the external ostium of the cervix and in the posterior fornix of the vagina. Both tubes are occluded at the proximal extremities. The shadows extending from the fornices of the uterine cavity are cast by ridges of denser bone in the sacrum as can be seen readily by stereoscopic examination, again demonstrating the importance of this procedure.

FIG. 9. The uterus is rather sharply anteflexed. Both tubes are occluded at the proximal extremities due to previous inflammatory disease, now quiescent.

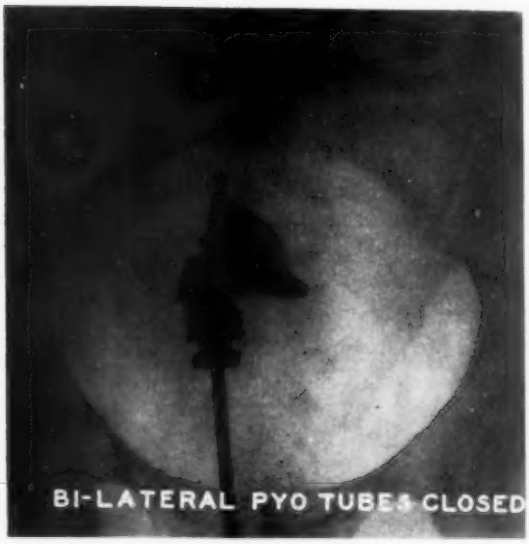

FIG. 10. The uterus is sharply anteflexed. Both tubes are occluded at the proximal extremities due to the presence of chronic bilateral pyosalpinx. A small fibroid nodule palpable in the anterior uterine wall does not show any evidence of its presence in the roentgenogram.

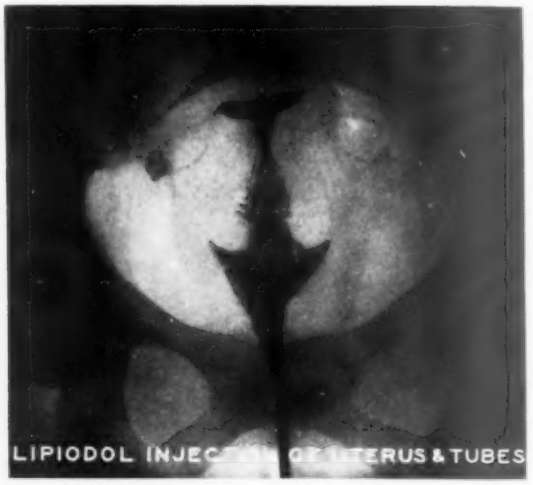

FIG. 11. This case of sterility is discussed in detail. The uterine cavity is very small. The tubes are patent only to their outer extremities, although the right tube appears to allow the solution to pass into the peritoneal cavity. Both tubes were proved at operation to be sealed at the distal ends.

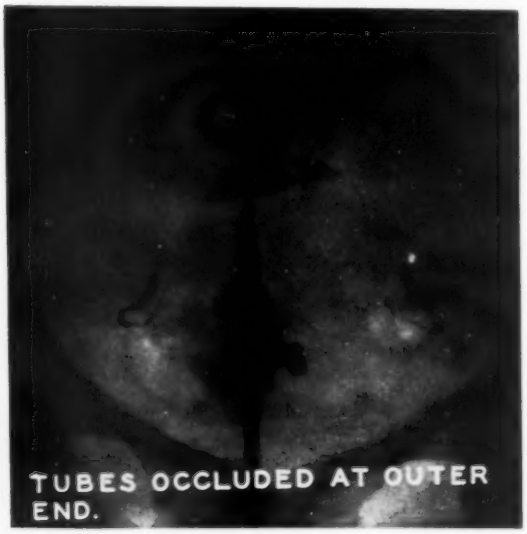

FIG. 12. This case of sterility is discussed in detail. The distal extremities of the tubes are sealed although, from casual examination of a single roentgenogram, it would be impossible to tell whether the shadows were cast by solution in the tubes or in the peritoneal cavity. This again illustrates the necessity for stereoscopic examination and the importance of taking roentgenograms subsequently to show the presence of solution in the peritoneal cavity, as will be explained later.

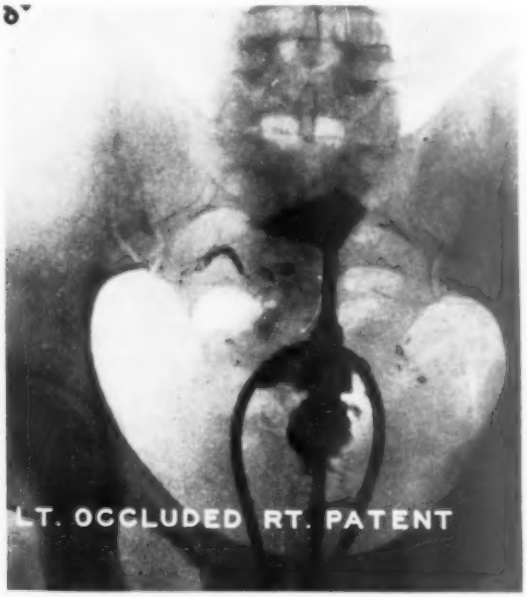

FIG. 13. In this case the left tube and ovary were removed by one of the authors eleven weeks before the roentgenogram was taken. The right tube is patent. Traces of the solution can be seen in the peritoneal cavity on the left side proving that the presence of solution on one side does not necessarily prove the patency of the tube on that side. The roentgenogram was taken immediately after injection without moving the patient.

FIG. 14. This interesting case of sterility will be discussed in detail later. On the left side, the isthmus and about one-half an inch of extramural tube are patent. The right tube is occluded at the isthmus. The roentgenographic findings were verified by the findings at subsequent operation.

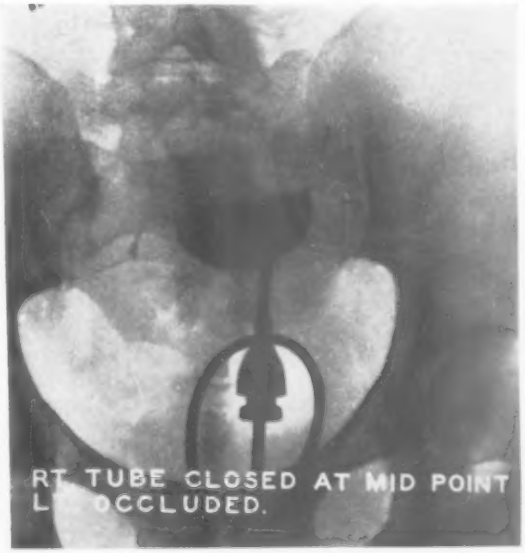

FIG. 15. In this case, the left tube had been removed flush with the uterine surface and the right tube about one-half an inch from the surface, at a previous operation. The intramural portion of the left tube and the intramural portion with about one-half an inch of the right tube are clearly demonstrated. The distal extremities of the portions of both tubes are occluded. These findings were verified at subsequent operation by the author. Note the large size of the uterine cavity. At examination, the diagnosis was subinvoluted or hyerplastic type of uterus.

due to small sharp kinks, which have been repeatedly observed by the authors at operation when exploring the lumen of a tube with a probe. This factor probably obtains in Case IV just described as observable in Figures 19, 20 and 21.

Lest the reader, being too greatly influenced by the possibilities of error just described, doubt the value of the test, let it be stated that these cases are exceptions to conditions commonly found. Normal patency of tubes is ordinarily easily demonstrated as shown in Figures 1, 2, 3 and 4. The penetrating properties of lipiodol cannot be doubted after observing the manner in which it penetrates into minute orifices, as, for example, the intramural portions of tubes previously removed flush with the external uterine surfaces as shown in Figures 15 (left) and 16 (left); into the remaining portion of a tube previously resected about an inch from the uterine cavity as in Figure 15 (right) and into a portion of a tube to a point of pathological constriction as in Figure 14 (left); into a small cavity in the wall of the uterus as in Figure 18; and

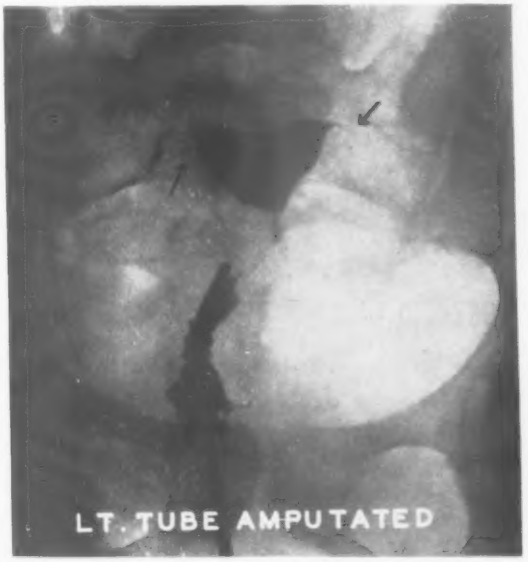

FIG. 16. This case is one of multiple fibromyoma of the uterus. One very large tumor was in the lower uterine segment displacing the cervix far forward against the bladder. Note the position of the cannula. The concavity of the upper border and the double concavity of the left side of the uterine cavity are caused by encroachment of nodules. At a previous operation, the left tube had been removed flush with the surface of the uterus. The shadow of the solution can be clearly seen in the intramural portion of the left tube. The right tube is occluded at the outer extremity. These findings were verified at subsequent operation performed by one of the authors.

into the lumina of tubes for the entire lengths to the occlusions at the distal extremities as in Figure 11 (right and left). All these examples were proved by subsequent operation by one of the authors. In fact, the diagnostic findings have proved remarkably accurate by the findings at subsequent operation, and confidence in the test in creases with greater experience.

The possible sources of error are discussed at length to stress the necessity: (1) of taking roentgenograms at various intervals and under various conditions of intrauterine pressure; (2) of stereoscopic examination, and (3) of taking late roentgenograms after an interval of twenty-four to forty-eight hours.

Fig. 17. This is a case of moderate retroversion of the uterus. In taking roentgenograms with the patient in the dorsal position, the actual shape of the uterine cavity is more clearly demonstrated in cases of retroversion than in cases of anteversion. The left tube is occluded about an inch from the uterine cavity and is probably somewhat constricted in the patent portion causing the very faint shadow. The right tube is occluded at the isthmus. The condition is the result of previous inflammatory disease, now quiescent.

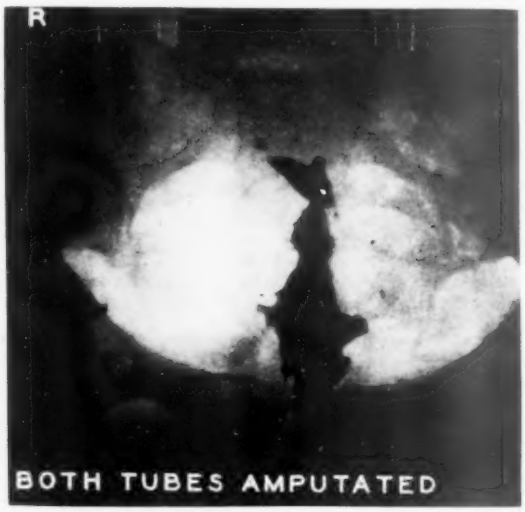

Fig. 18. This patient was operated on by the author two years ago. The case was one of tuberculous salpingitis. There were two small tuberculous nodules in the uterine wall situated almost symmetrically, one on each side, directly above the intramural portion of the tube. This necessitated removal of the tubes with the tuberculous nodules by deep wedge-shaped incision into the body of the uterus. Whether there occurred sloughing following the operation or the subsequent breaking down of a caseated nodule is not known but the solution has found its way into a small cavity in the wall of the uterus on the right side. Note the small size of the uterine cavity due to atrophy following removal of the ovaries.

THE IMPORTANCE OF ROENTGENOGRAPHY IN STERILITY

Watkins[17] states: "The justification of abdominal section for occlusion of the tubes with the small percentage of successes, remains problematic. Intensive study of a large amount of material is needed as many factors obtain and treatment is relatively unsatisfactory." This statement expresses exactly the present status of the relation of operative procedure to the relief of sterility. It is not within the scope of this paper to discuss the general aspects of sterility, the object being only to consider the relation of roentgenography of the fallopian tubes to the indications for operation. It is assumed that all other factors in the causation of sterility will be excluded or given proper consideration before operation is even suggested.

The unsatisfactory results of operation for the relief of sterility depend largely upon the inability of the gynecologist to make an exact diagnosis of the actual pathological condition of the tubes before operation. It necessarily follows that many cases are operated upon uselessly. Until

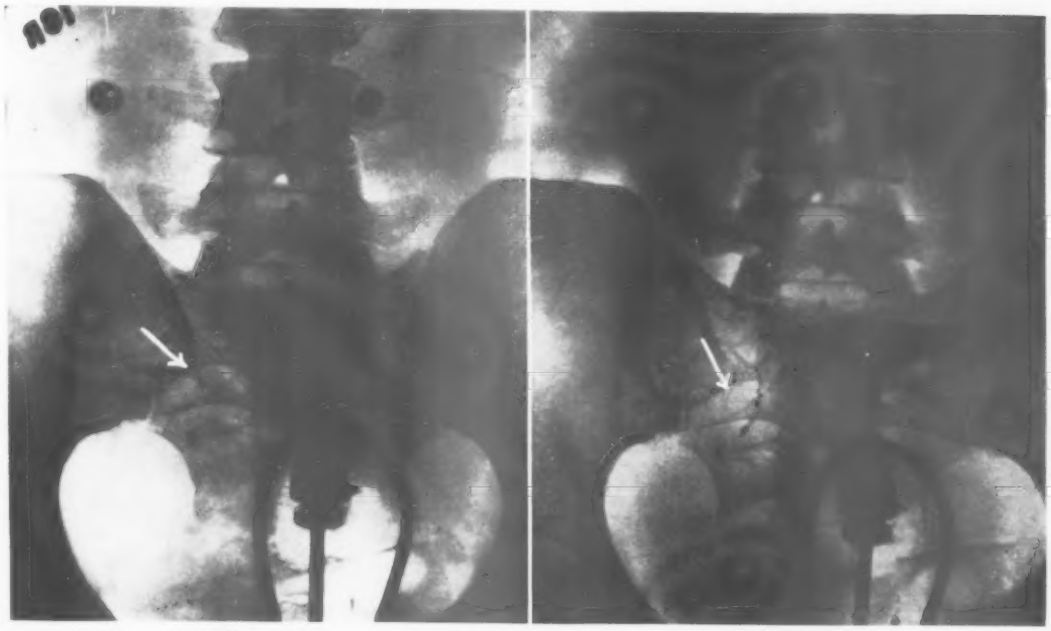

FIG. 19. FIG. 20.

FIG. 19. This case is presented to illustrate the delayed filling of the tubes which occasionally occurs and which will be fully discussed later. Comparison with Figures 20, 21 and 22 is necessary for the accurate interpretation of the actual conditions. In this roentgenogram the right tube shows the shadow of the solution in its lumen for about an inch (see Fig. 20).

FIG. 20. This is a stereogram of Figure 19 taken about two minutes afterward. There was absolutely no movement of the cannula or change in position of the patient. It clearly demonstrates that the solution has passed about an inch farther into the tube (see Fig. 21).

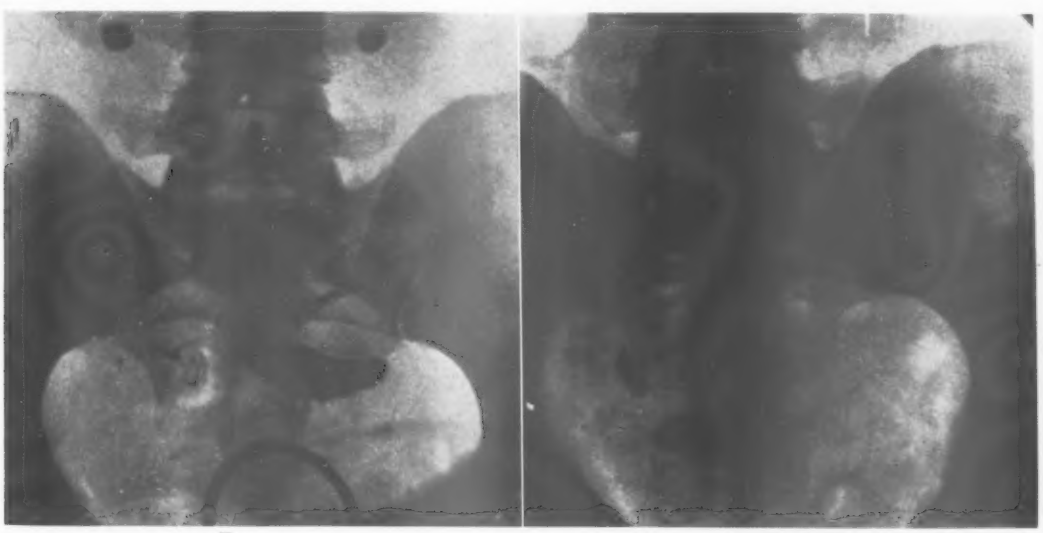

FIG. 21. FIG. 22.

FIG. 21. Another roentgenogram of the case shown in Figures 19 and 20. The cannula was removed from the cavity of the uterus and the roentgenogram taken about five minutes after Figure 20. The cavity of the uterus has dropped somewhat lower than in Figure 20 thereby changing the shape of the shadow of the tube. The right tube is now filled to the distal extremity and the solution is passing into the peritoneal cavity as is proved by Figure 22.

FIG. 22. This roentgenogram of the case shown in Figures 19, 20, and 21 was taken forty-eight hours afterward. The presence of solution in the peritoneal cavity proves conclusively that the right tube is patent.

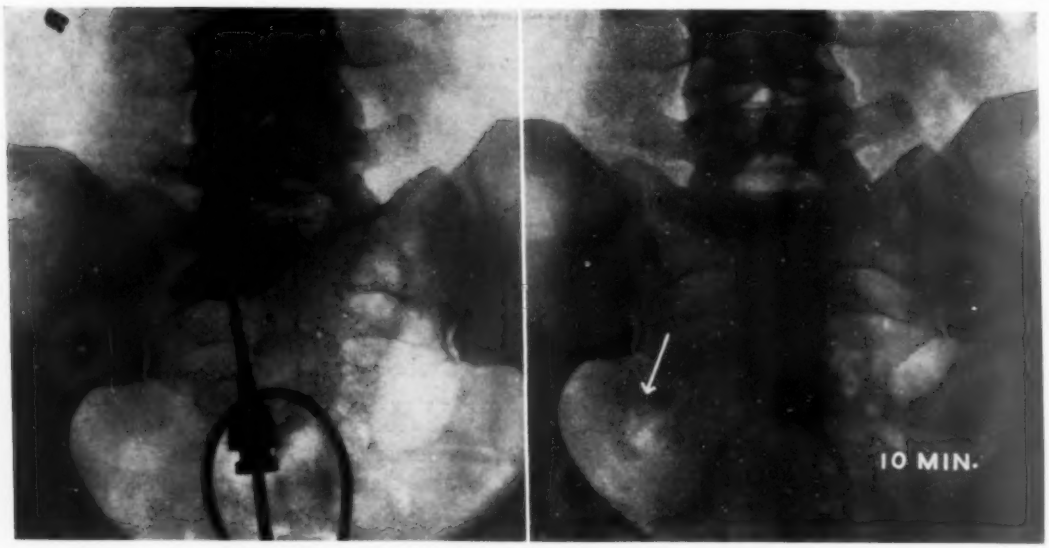

Fig. 23. Fig. 24.

Fig. 23. This case is presented to demonstrate the filling of the tube after the intrauterine pressure is removed. Attention is called to the right tube. It would appear in this roentgenogram that the right tube is occluded at the isthmus. This is not the case as will be seen by examining Figure 24.

Fig. 24. This roentgenogram is the same case shown in Figure 23. Four of the 5 c.c. of the injected solution was removed by suction into the syringe. The roentgenogram was taken ten minutes after the first. It is clearly demonstrated that the solution has passed into the right tube after the removal of intrauterine pressure. Note also the sharp outline of the cavity and its small size compared with the size shown in Figure 23. The uterine cavity is distensible under the influence of intrauterine pressure and able again to resume its original size after removal of the pressure.

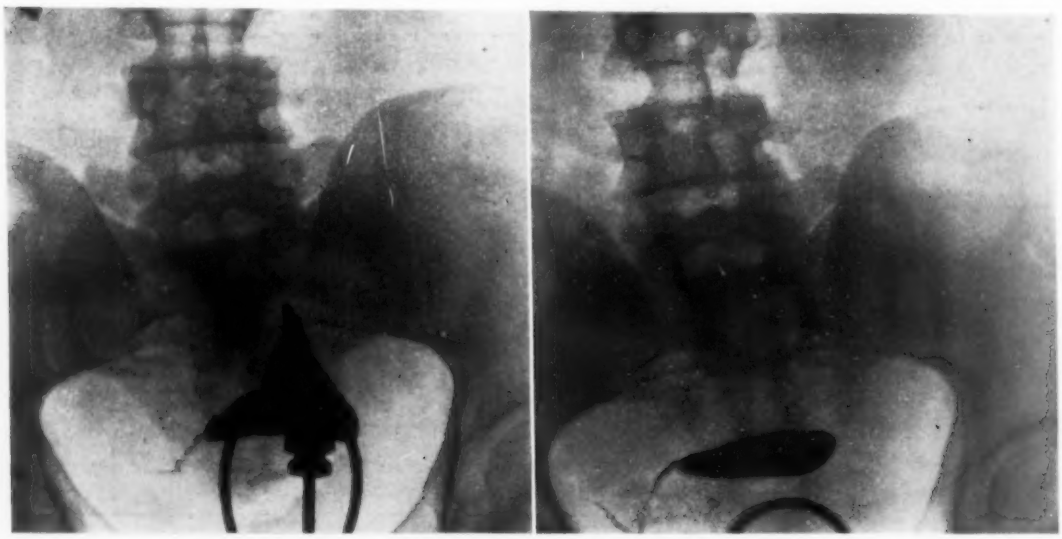

Fig. 25. Fig. 26.

Fig. 25. This case illustrates the same conditions shown in the two preceding cases. Attention is directed particularly to the right tube. In this roentgenogram the right tube is shown partially patent. Compare with the picture shown in Figures 26 and 27. This figure also demonstrates the appearance of the uterine cavity in cases of acute anteflexion.

Fig. 26. This shows the same case as Figure 25. Four of the 5 c.c. of the injected solution was withdrawn by the syringe and the cannula removed. It is clearly seen that the solution has penetrated farther into the tube (see Fig. 27).

the advent of the Rubin test, even the diagnosis of patency of the tubes was not possible. Insufflation of the tubes was a marked advance but even this test does not indicate the point of occlusion of the tubes, a very important factor in determining the indication for operation. Occlusion at the isthmus gives a very poor outlook for improvement after operation. The farther out from the uterus the occlusion exists, the better the chances for the success of the operation. Occlusion at the distal extremities would seem to provide a reasonable indication for operation when it is remembered that it is the only possible way to accomplish a result which is so vitally important to the patient. If the results of the operations in use at the present time are not very satisfactory, it is to be expected that, with clearer indications more cases will be operated on and in the future the technique will be so much improved that the procedure will emerge from its present status of very doubtful repute.

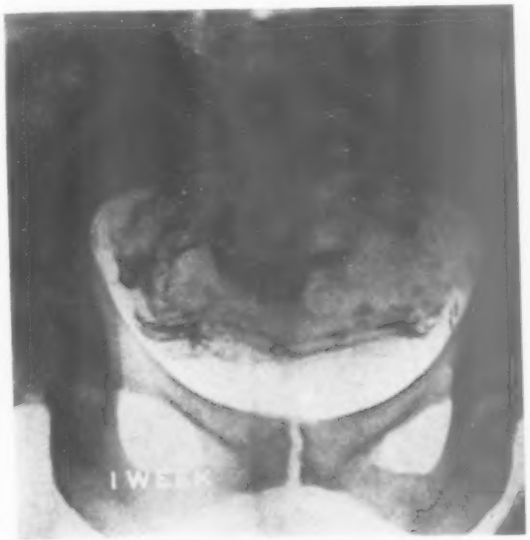

FIG. 27. This roentgenogram was taken one week after Figure 26. The presence of the solution in the peritoneal cavity demonstrates that the right tube is patent.

The authors believe that the results of roentgenography of the tubes can be thoroughly relied upon if conducted with proper care and attention. It has been shown by the presentation of many instances that not only the diagnosis of

FIG. 28.

FIG. 29.

FIG. 28. This is another case to demonstrate the difficulty of diagnosing accurately the complete patency of a tube from a casual examination of a single plate. The left tube presents an appearance which cannot be diagnosed as patent at the distal extremity. However, comparison with Figure 29 proves this to be the case.

FIG. 29. This roentgenogram taken twenty-four hours after Figure 28 shows the solution in the peritoneal cavity, proving the patency of the tube.

patency but the point of occlusion of a tube can be accurately demonstrated.

Fig. 30. Case shown in Figures 28 and 29. Roentgenogram taken five days after injection.

Fig. 31. Case shown in Figures 28, 29 and 30. Taken one week after injection.

As practical examples of the efficiency of the test, 3 cases of sterility will be briefly described with reference particularly to operative indications and findings, the technique of the operations being considered beyond the scope of this paper.

The roentgenogram of the first case is shown in Figure 11. The sterility was of five years' duration. Nothing in the history indicated, in any way, a cause for the condition. On examination a moderately hypertrophied cervix, a rather small fundus in normal position and to palpation, apparently normal adnexa were found. The Rubin test showed the tubes to be occluded at 230 mm. Hg in three tests. The roentgenograms indicated that the tubes were patent to the distal extremities but that no solution passed into the peritoneal cavity. At operation the left tube was found sealed into a club shaped extremity about as large as the tip of a finger with destruction of the fimbriae. On the right side the fimbriae were not destroyed but the tube was sealed by adhesions encircling the extremity of the tube and holding it against the right broad ligament. On separation of these adhesions it was possible to pass a probe through the entire length of the tube. The left tube was also opened and the tubes and ovaries suspended to the upper border of the broad ligaments. Four weeks later the Rubin test showed the tubes patent at 140 mm. pressure.

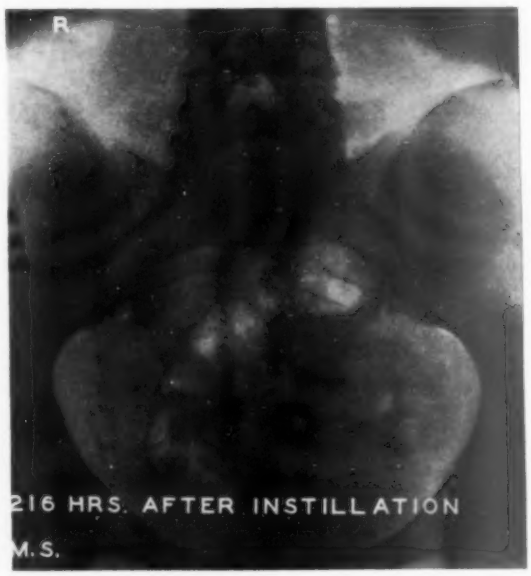

Fig. 32. Case shown in Figures 28, 29, 30, and 31. Taken nine days after injection.

The authors are indebted to Dr. F. H.

Mosler for the opportunity to test the following case and to be present at the condition of the tubes could be traced to a definite gonorrheal infection which

FIG. 33.

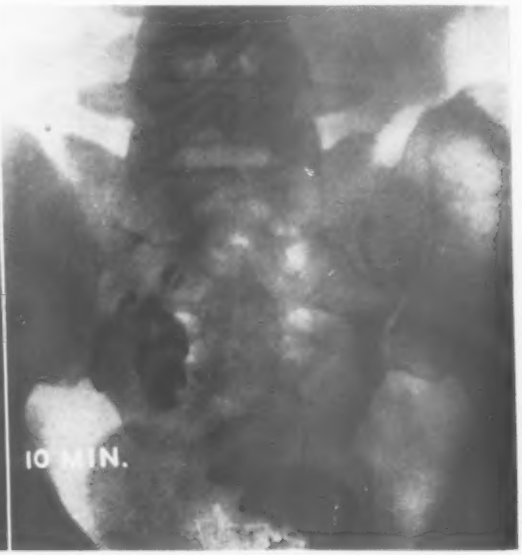

FIG. 34.

FIG. 33. This roentgenogram is introduced to show the rapidity with which the cavity of the uterus sometimes empties itself into the vagina. Five cubic centimeters of solution was injected before this plate was taken. Compare with Figure 34.

FIG. 34. After taking the roentgenogram shown in Figure 33, the cannula was withdrawn without removing any solution. This roentgenogram was taken ten minutes later. The uterus has almost emptied itself, the solution appearing in the vagina. In this case the left tube is occluded at the isthmus, the right tube patent.

FIG. 35. Case shown in Figure 4. Taken forty-eight hours after injection.

FIG. 36. Case shown in Figure 4. Taken seventy-two hours after injection.

operating table to verify the results and for permission to publish the case. The had been cured. Repeated Rubin tests showed the tubes to be occluded. All

other factors in the causation of sterility were eliminated. Figure 14 demonstrates occlusion of the right tube at the isthmus and occlusion of the left tube about one inch from the fornix of the uterus. At operation, these results were beautifully corroborated. An extremely interesting condition was observed. On the left side, there was an area of the tube about three-quarters of an inch long in which the lumen of the tube was completely obliterated. This started about one-half inch from the

FIG. 37. Case shown in Figure 4. Taken four days after injection.

FIG. 38. Case shown in Figure 4. Taken one week after injection.

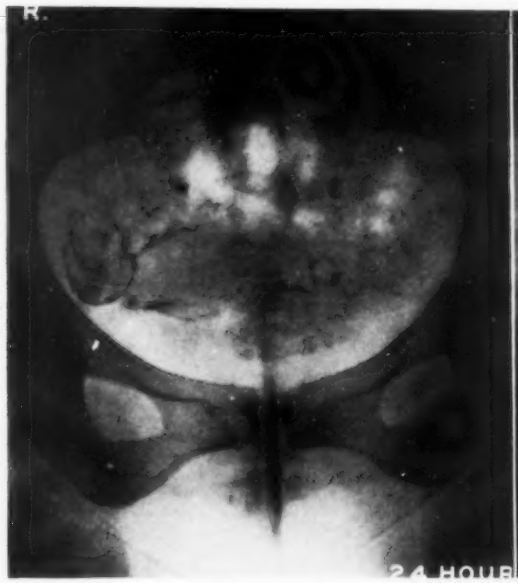

FIG. 39. Case shown in Figure 2. Taken twenty-four hours after injection.

FIG. 40. Case shown in Figure 2. Taken forty-eight hours after injection.

uterine wall, the remainder of the patent portion shown in the roentgenograms being intramural. The right tube was found to be obliterated at the isthmus as diagnosed by the test. After resection of the left tube removing the occluded portion, a probe could be passed with ease into the uterine cavity. One of the interesting features of this case is, that to casual inspection, the tubes appeared perfectly normal. The distal extremities were normal and there were no adhesions present.

The third case is shown in Figure 12. This is also a case of sterility of five years' duration. The etiological factors for the sealing of the tubes could not be determined. The roentgenogram showed the fimbriated extremity to be occluded on each side. The Rubin test was negative at 220 mm. pressure at trials on three different occasions. The case is a favorable one for operation and the patient is waiting for an opportunity to undergo operation.

In all these cases a definite diagnosis of the position of occlusion of the tubes can be made with certainty. The operations are clearly indicated. All three patients had been uselessly treated for several years and all three were willing, even anxious, to undergo operation, although the doubtful prognosis was thoroughly explained.

The authors believe that roentgenography of the fallopian tubes is of great importance in cases of this kind and that the efficiency of the gynecologist is enhanced by the aid of a test which is accurate, simple and safe.

SUMMARY

1. Lipiodol is a very effective agent for roentgenography of the cavity of the uterus and the lumina of the fallopian tubes.

2. Roentgenography is a valuable addition to the diagnostic methods of the gynecologist.

3. Although interesting in other respects, the greatest practical value of the test is in determining the patency or position of occlusion of the fallopian tubes.

4. For obtaining accurate results with this test, stereo-roentgenography is essential and certain errors must be guarded against.

5. With the aid of this test, it is to be expected that much needed advances in the study of the relief of sterility due to occlusion of the fallopian tubes, will be made.

FIG. 41. The negative character of this illustration is its important feature. The case is one of very large fibromyoma with numerous smaller nodules of which there is no evidence in the roentgenogram. The right tube is patent, the left tube occluded at the isthmus.

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THE SELLA TURCICA*

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WE have often to answer the question, "Can you differentiate a normal sella from a pathological sella?" and another question, "Can you diagnose by a roentgenogram of the sella a hypertrophy or an atrophy of the pituitary gland?"

These questions are asked mostly by the endocrinologist, but also by other specialists in cases showing adiposity, or the contrary, or in cases showing abnormalities of the sexual organs, either organic or functional, also in cases showing abnormalities of the hair, or in cases of diabetes insipidus.

The pituitary fossa is not a really closed box for the pituitary gland. The upper wall is formed by the membranous diaphragm of the sella, a part of the dura separating the brain cavity from the pituitary cavity. There is no bony wall on top of the pituitary fossa; from a lateral view of the skull, the anterior clinoid process seems to be the roof of the pituitary fossa, but it really lies farther laterally.

The relation of the pituitary fossa and the pituitary gland can also be seen on the posteroanterior view, corresponding to the

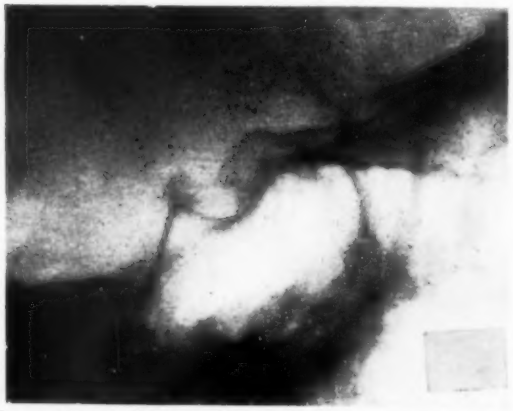

Fig. 1. The sella is small in the anteroposterior direction and also very flat, due to a large sphenoidal sinus filling the whole body of the sphenoid.

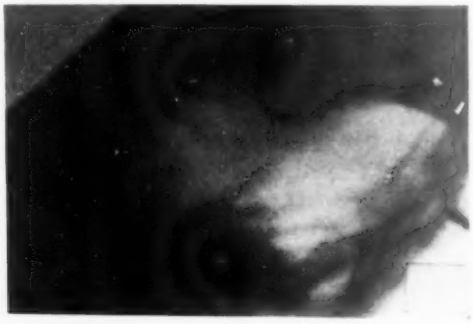

Fig. 2. Shows a case similar to Figure 1.

* Read at the Twenty-seventh Annual Meeting, American Roentgen Ray Society, Detroit, Mich., May 17–21, 1926.

frontal sections through the sphenoid body. On this view the floor of the pituitary fossa forms a straight or a slightly convex line, convex upward. There is no bony wall on either side of the pituitary fossa. There-

FIG. 3. The floor of the sella is seen from in front as a convex line between the top of the sphenoid body and its floor; there is no lateral wall of the sella seen at all.

fore, we understand that *the pituitary gland can be hypertrophied without causing a visible enlargement of the sella.*

In cases where the piuitary gland is atrophic, the sella is usually not smaller than normal, because the soft parts lying around the pituitary fill the empty space. Therefore, we see that the pituitary fossa does not correspond exactly to the shape and to the size of the pituitary gland.

The shape of the pituitary fossa is variable. We can distinguish three types, the semicircular type, the oval type and the circular type. These differences are due not so much to the shape of the pituitary or to the shape of the other intracranial organs; they are more dependent on *the shape of the sphenoidal sinus.* If the sphenoid sinus is very large, undermining the sella, or if the sinus fills also the dorsum sellae, then the flat type of sella is produced.

Sometimes we find a *smaller sella* also in cases of *idiocy*. In these cases the skull is too large for the small brain and we get a compensatory thickening of the interior surface of the skull.

We find the thickened sella sometimes in cases of *healed* hydrocephalus as a part of the thickening of the whole skull. The thickening in these cases is not the cause but the result of the condition of the brain. Another variation of the sella corresponds to "*bony bridges*" in the dura of this region. These ossified bridges were often diagnosed as pathological processes by Johnston, who suggests that these ossifications are the cause of epilepsy; by Wieser, who supposed these bridges to be the cause of idiocy; and also by Hirtz, who considers that these bridges are due to infections of the dura, caused by inflammatory processes of the sphenoidal sinuses.

The different types of bridges in the region of the sella described as pathological processes due to inflammation of the meninges or due to hemorrhages at the base of the brain are really normal variations of the sella.

The anterior, middle and posterior clinoid processes of the same side are united by ligaments (*interclinoid ligaments*). Two other ligaments extend from the crest

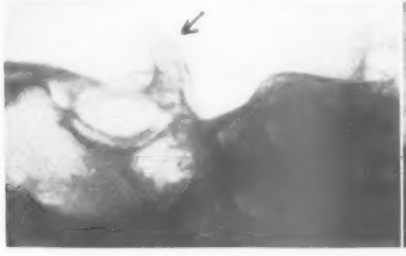

FIG. 4.

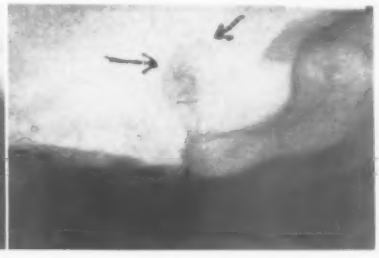

FIG. 5.

FIGS. 4 and 5. Showing an elongated dorsum.

of the petrous portion to the anterior and posterior clinoid process of the same side; on these two *petroclinoid ligaments* the tentorium is attached.

In the five ligaments described in the anatomy as interclinoid and petroclinoid ligaments we very often find bony bridges, in children as well as in adults. We can see these five bridges very well in a roentgenogram of the skull made in the transverse direction.

Fig. 6. Shows the dura of the clivus or basilar process ossified.

Another detail diagnosed as a pathological process is what we call the "*elongated dorsum sella.*" The anterior clinoid process and the end point of the dorsum sellae lie fairly in a horizontal plane running parallel to Reid's base line. Not so rarely do we see an elongation of the dorsum sellae going far over the level of the anterior clinoid process.

Fig. 8. Shows a bridge going from the anterior to the posterior clinoid process.

This elongated dorsum corresponds also to a structure we find normally but only during the embryonal life. There is a plate of the dura going from the dorsum up against the base of the brain, and if this plate of the dura persists and ossifies then we find this elongated dorsum. Therefore, the ossified ligaments in the region of the sella and the elongated dorsum are normal structures, not caused by an inflammatory process or by hemorrhages in the meninges. The question is whether these variations can cause clinical symptoms. We can say that they are without clinical importance, except the elongated dorsum, which in a

Fig. 7. Shows bridges going from the middle clinoid process to the posterior and to the anterior clinoid process on both sides.

case where the base of the brain is pressed down by an increased intracranial pressure can cause clinical symptoms of a lesion of the floor of the third ventricle.

A detail we find often in the region of the sella on the side view are the shadows of the ridges *on the lateral wall of the skull*,

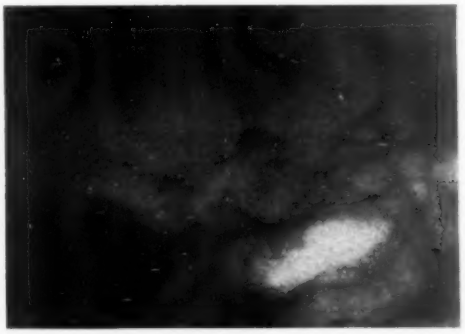

Fig. 9. Shows the connection of the dorsum sellae with the petrous portion (lateral petroclinoid bridge).

corresponding to the sulci of the brain, and then not so rarely some mastoid cells overlapping this region.

ANOMALIES OF THE SELLA

The most common types of anomalies are destructions of the sella. We find destruction of the dorsum sellae very often

in senile persons. The sella appears eroded. The dorsum sellae is the part of the skull which first shows senile osteoporosis. Also the carotid artery lying by the side of the dorsum sellae pulsates against it and eats it from both sides.

Destruction of the sella is found also in cases of *inflammatory* processes of the sphenoid body, due to osteomyelitis, lues

FIG. 10. Shows the median petroclinoid bridge going from the petrous portion up to the anterior clinoid process.

or tuberculosis. These destructions due to inflammatory processes are similar to the destruction due to malignant tumors of this region: we find an invasion of the bone, the outlines of the floor of the sella, as well as the shadow of the sphenoidal body are

FIG. 11. Shows a double outlined floor of the sella; the lower one corresponds to a partial erosion of the sella by an endosellar, unilateral pituitary tumor.

washed out. We do not see an enlargement of the sella in these cases; we see only a dull outline of the sella as well as of the sphenoidal body and sphenoidal sinus.

The third type of destruction of the sella is due to *intracranial processes*, mostly tumors starting either in the brain, the pituitary gland, the meninges, the cranial nerves or the arteries. In these cases we do not find an invasion of the sphenoid. The sella is only enlarged and is therefore abnormal in shape. The remaining part of the sphenoidal body and sinus is normal in structure and in density.

The type of the deformity of the sella is either a deep or a flat one. Both types can be due to all kinds of intracranial processes, to general intracranial pressure caused by hydrocephalus, as well as to a localized pressure caused by a pituitary tumor, an aneurysm of the carotid artery, a tumor of the dura, a cyst of the cistern of the chiasm or a tumor of the basilar nerves. But the flat type is found mostly in cases of tumors lying above the sella, the deep type in cases of intrasellar tumors, though we find the same type also rarely in cases of intracranial pressure. In cases of intracranial pressure due to premature closure of the sutures (craniostenosis) the sella is not eroded. Only if the intracranial pressure is due to a hydrocephalus do we find an enlargement of the sella.

In cases of general pressure and of tumors lying above the sella the anterior clinoid process is mostly thinner and shorter, but there is no destruction seen of the anterior clinoid process in cases of intra-sellar tumors; often in these cases the

FIG. 12. This represents a case of a large erosion of the sella, where the anterior clinoid process is very large.

anterior process is larger, corresponding to the general hypertrophy of the bones due to acromegaly.

Therefore we can differentiate well the invasion of the sphenoid body by a malignant or an inflammatory process from the erosion of the sella due to pressure; but we

cannot differentiate so well the erosion of the pituitary fossa caused by general intracranial pressure from the enlargement of the sella due to localized tumors. The principal differential prints are the following:

(1) In cases of general pressure the floor of the sella is mostly single; in localized tumors there are often seen two or three outlines of the floor of the sella because these localized processes often lie asymmetrically.

(2) The anterior clinoid process in cases of general pressure is usually thin; in localized tumors normal or thicker.

(3) In localized tumors calcification is often seen in the region of the sella.

RADIUM NECROSIS OF BONE

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THE action of radium on bone when applied locally is similar to that on other tissues in that it results in necrosis if the irradiation is of sufficient duration and magnitude. However, the difficultly penetrable lime salts of the bone restrict the necrosis to a smaller area than that following an equivalent irradiation of soft parts. By producing necrosis in this way, the dead bone is left with its attachments to the living bone undisturbed. Consequently it continues to function mechanically as a part of the skeletal structure. Since much of the skeleton is deep-seated, it is possible by means of buried radium to kill extensive areas of bone without injury to the external layers of the overlying soft parts and thus keep the necrotic field free from infection.

Experiments were performed on adult dogs for a study of the fate of the dead bone and of the reaction of the adjacent living bone, both with and without the influence of function and with and without associated infection. The changes that follow the killing of bone by radium in the treatment of human sarcoma were studied in 3 cases by means of roentgenograms and in one case by examination of the specimen obtained at autopsy.

It is a well-known fact that bone killed by bacterial infection is generally either absorbed without replacement *in situ* by new bone, when it is in small amounts, or sequestrated when it is in large amounts. The fate of bone killed in the absence of bacteria, as by interruption of its circulation or by chemicals, is less well known. Interruption of circulation in bone transplantation leads to aseptic necrosis of the bone, which gradually is replaced by new bone coming mainly from unossified osteogenic elements that survive the transplantation. Nussbaum's[1] experiments showed that interruption of the circulation of the center of ossification of an epiphysis leads to necrosis of the bone and marked absorptive and structural changes, but with eventual restoration of a bony center that differs little from the original. Axhausen[2] killed bone by the direct application of heat, cold and tincture of iodine and found that the dead bone was gradually replaced by new bone without sequestration. Bancroft[3] produced extensive necrosis of the shaft of the humerus in dogs by the injection of croton oil. An involucrum formed about the dead portion of shaft, which also became sequestrated, showing that croton oil produces a marked chemical inflammatory reaction. However, as this inflammatory reaction subsided more rapidly and completely than does an equally severe one produced by bacteria, the fate of the sequestrum was different in that it was rapidly absorbed and

replaced by new bone, in contrast to a sequestrum in pyogenic osteomyelitis which is very slowly absorbed.

There are obscure lesions of the epiphyses, as Legg-Perthes' disease, Köhler's disease, Osgood-Schlatter's disease, and osteochondritis dissecans, that are characterized by necrotic, absorptive and proliferative changes in varying degrees. They have been assumed by many to be the result of interruption of circulation to the affected region, the cause of the interruption remaining a debated one. Osteochondritis dissecans may be taken as an example. In it a biconvex disc-shaped mass of bone and cartilage along an articular surface—particularly along the lateral surface of the mesial condyle of the femur—becomes separated from its bed and eventually goes free into the joint as a loose body. The old view as to etiology was that it was an intra-articular fracture. A history of preceding trauma, at least of considerable violence, is often absent. More recently it has been assumed that there is traumatism or embolism of the artery supplying the region, thereby cutting off the blood supply, and leading to necrosis and subsequent sequestration with sloughing of the necrotic piece into the joint.

In order to produce experimentally an aseptically necrotic mass of bone and cartilage approximately of the size and position of the body that becomes detached in osteochondritis dissecans, a 12.5 mg. needle of radium was inserted into the knee of a dog, in contact with the lateral surface of the mesial condyle of the femur, and left for eighteen hours, the joint being immobilized by a cast. There were four experiments, in which the animals were sacrificed 88, 97, 252, and 400 days after the use of the radium. In all instances the joints functioned normally. In no instance was there sequestration of the necrotic area or loose body formation. At necropsy in the first three experiments the articular cartilage of the irradiated area had a yellowish-white tinge, and sagittal section of the condyle through the exposed region showed an oval-shaped area of dark brown bone extending $^2/_3$ to 1 cm. beneath the surface at its broadest point and surrounded by a lighter zone with fibrous marrow. Beyond this the bone and marrow were normal in appearance. The articular cartilage overlying the exposed area showed little gross change on cut section.

On microscopic examination the exposed cartilage and underlying brownish bone were found to be dead, with disintegration of cells and moderate infiltration of marrow spaces by old blood. The lighter zone about the periphery consisted of dead bone in its deeper portion with sparsely cellular white fibrous connective tissue filling its marrow spaces. In its outer portion the bone was alive and new bony trabeculae were forming to take the place of dead ones that were being absorbed. The layer of dead cartilage at its periphery had been replaced slightly by fibrocartilage, but centrally it was of normal thickness and showed practically no trace of cartilage cells. Figure 1 is a photograph of a sagittal section of the 97-day experiment. There was marked marrow fibrosis about the periphery of the dead area, which extended from *a* to *b*, but very little absorption of dead bone and few new ingrowing trabeculae. In the 252-day experiment there was much more new bone about the periphery and the necrotic area was about two-thirds the size of that shown in Figure 1. In the 400-day experiment there was only a very small area of necrotic bone remaining along the surface, and the overlying articular surface was covered by a layer of fibrocartilage that had replaced the dead articular cartilage.

These experiments on a functioning limb show that instead of sequestration there is a very slow creeping replacement of the necrotic bone by new bone. The reason for this very slow replacement is no doubt to be found in the radium burn of the tissues about the completely necrotic portion, as shown by the presence of sparsely cellular connective tissue in the marrow spaces about the dead areas. The condition is analogous to the slow healing of radium burns of the soft parts in man.

While the condition here presented is not entirely analogous to that assumed for osteochondritis dissecans, still the findings speak against the theory that the loose body in that condition is the result of sequestration of an aseptic necrotic mass of

bone and articular cartilage. They favor the chip-fracture theory.

Large areas of the shaft of humerus or femur were killed by the introduction of radium needles into the medullary canal through a small hole made either in the top, the needles being carried downward by a spike, or in the side of the shaft. Roentgenograms were taken at two to five months' intervals and much information was thereby obtained about the changes that took place in the irradiated bones. Either 37.5 or 59 mg. of radium were introduced and removed in twenty to twenty-four hours. It was found that these amounts nearly always killed the entire surrounding segment of shaft, including marrow and periosteum, for a length of 3 to 5 cm.,

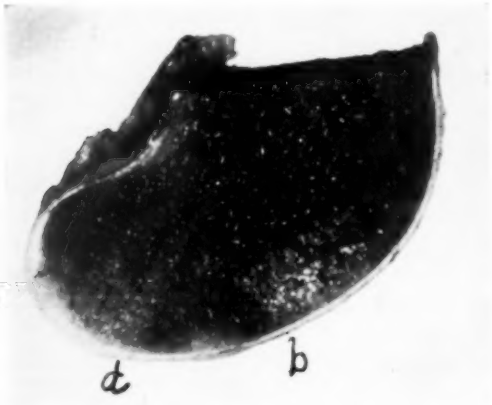

Fig. 1. Sagittal section of condyle of femur ninety-seven days after exposure to radium. Area from *a* to *b* necrotic. No sequestration.

depending on whether the needles were kept together or were strung out along the medullary canal. The surrounding muscles were also burned more or less extensively, and at necropsy their necrotic portions were found to be more or less completely replaced by fibrous tissue, depending on the age of the experiment.

EXPERIMENTS

There was one 44-day and another 250-day experiment on the femur and a 272-day experiment on the humerus, in which there was no infection and no subsequent fracture of the necrotic segment. The dogs used the limbs normally, running about after a few days as if nothing had been done to them.

Forty-four Day Experiment. Dissection of the limb in the 44-day experiment showed the periosteum and muscles about the irradiated shaft to be necrotic and detached from it for a distance of 2 cm. The cortex of the irradiated segment was smooth and there was only slight thickening of periosteum on the living shaft beyond at either end. On longitudinal section of the shaft the medullary cavity at the irradiated level was full of necrotic débris and greyish fibrous tissue. Beyond this at either end the medullary cavity was filled for a distance of about 1 cm. with spongy new bone. Microscopic examination showed dead cortex in the bare region and practically no new bone invading the dead portion at either end. There was no break in the cortex at the lines of junction of living and dead bone.

Two Hundred and Fifty Day Experiment. In the 250-day experiment 37.5 mg. of radium were inserted upward through a hole cut in the side near the middle of the shaft of the femur and left for twenty hours. Figure 2 shows a roentgenogram of the femur 100 days later. The irradiated shaft for a distance of 3 cm. at the level of irradiation shows no change. Below this there is a shadow cast by new bone in the medullary canal for a distance of 1.5 cm. Above this there is a similar shadow in the region of the medullary canal and also a thick external shadow on the anterior surface of the cortex from periosteal new bone formation. It extends downward over the surface of the irradiated cortex for a distance of $\frac{2}{3}$ cm. Figure 3 shows a roentgenogram of the dissected femur. During the 150 days that had elapsed since the previous roentgenogram the periosteal new bone had crept downward on the anterior surface of the cortex for a distance of $\frac{2}{3}$ cm., but endosteal new bone at the upper and lower ends had changed but little. On dissection the shaft at the irradiated level was found bare and smooth and surrounded by a layer of fibrous tissue that was loosely adherent. Bony thickening on the living shaft was slight below and marked above where it extended obliquely downward on to the dead area anteriorly.

Sagittal section of the shaft (Fig. 4) showed about 2 cm. of dead cortex anteriorly and 2.5 cm. posteriorly. It was of normal thickness and whiter than the living cortex above and below, which was gray from increased vascularity, but there was no evidence of sequestration along the lines of junction. About 1 cm. of the medullary tissue on the one side (Fig. 5) appeared to be invading and replacing the necrotic débris and on the other side (Fig. 6) it was being replaced by the slowly invading new bone. Microscopic examination of the cortex at the line of junction of dead and living bone showed invasion and replacement of the dead bone by new bone and

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 2. One hundred days after irradiation; x is at middle point of irradiated segment.
Fig. 3. Roentgenogram of specimen 250 days after irradiation.
Fig. 4. Sagittal section of specimen shown in Figure 3; x is irradiated segment.

cavity at the middle of the necrotic segment was filled with necrotic débris. On either side of this came first a segment 0.5 to 1 cm. long of dark connective tissue and then a segment of spongy bone about 1 cm. long, partitioning the medullary canal. On microscopic examination the connective dilatation of canals and increased vascularity of the living bone. The periosteal new bone overgrowing the anterior surface was also absorbing and replacing the dead cortex.

Comment. In this experiment a segment of the shaft of the femur about 3 cm. long,

including periosteum, cortex and medullary contents, was killed by radium and the dead bone remained attached to the living bone and functioned for 250 days. During that time there was slow creeping substitution of the ends of the dead cortex by new bone as shown by roentgen-ray and microscopic examinations.

Two Hundred and Seventy-three Day Experiment. The 273-day experiment on the humerus presented a very similar picture except that the radium needles lay near the mesial cortex and killed it and its periosteum for a length of 3 cm., while the cortex on the other side was killed for a cm. of irradiated shaft. Two weeks later the animal fractured the femur through the dead portion. It carried the limb without weight bearing for five or six weeks, after which it walked on it as before. Figure 8 shows the oblique fracture through the necrotic segment with overriding and callus formation on the 154th day of the experiment when the fracture was fifty-four days old. The smaller portion of the necrotic bone forms the end of the anteriorly overriding upper fragment. Figure 9 shows the condition on the 214th day of the experiment at which time bony union was complete, and the necrotic portion of the

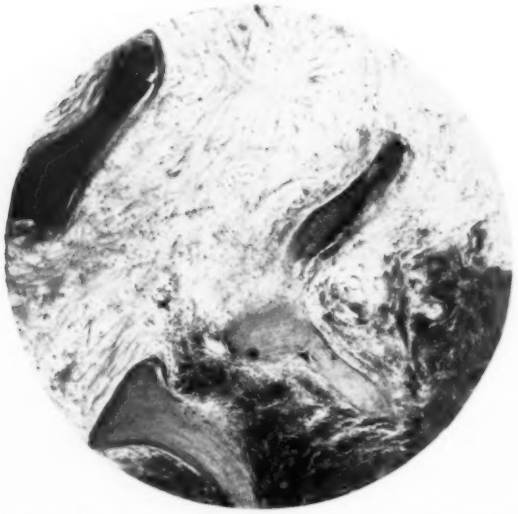

Fig. 5. Connective tissue replacing the necrotic tissue of medullary canal.

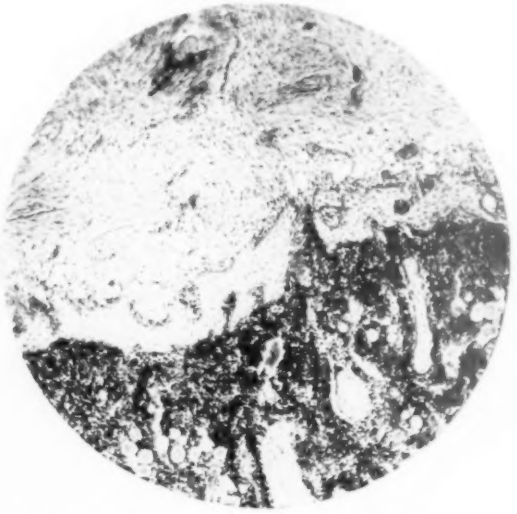

Fig. 6. Spongy bone growing in and replacing connective tissue of medullary canal.

shorter distance and was already covered by an adherent periosteum and largely replaced by new bone.

In one experiment in which there was no infection there was an oblique fracture through the necrotic segment of shaft. Bony union of the fracture followed promptly so that weight bearing was resumed and the influence of function on the fate of the dead bone in the field of a healed fracture could be determined. Thirty-seven and a half mg. of radium was inserted into the middle of the shaft of the femur and left for twenty hours. Figure 7 shows the roentgenographic appearance eighty-six days later. There is endosteal new bone, and anteriorly periosteal new bone, at both upper and lower limits of the 2.5 upper fragment, lying in the line of and incorporated in the abundant callus, had been largely absorbed and replaced by new bone. The larger necrotic portion of the lower fragment projecting posteriorly showed little change. A roentgenogram taken on the 360th day showed that the necrotic portion of the upper fragment had been entirely absorbed and replaced by new bone, while that of the lower fragment was much as is shown in Figure 9.

Figure 10 is of a roentgenogram of the bone removed when the animal was sacrificed after 573 days, and Figure 11 shows a photograph of a sagittal section of the specimen. The protruding necrotic end of the lower fragment, lying outside of the field of bone which bore the stress

and strain, showed evidence of surface absorption at its tip, but the remaining portion was little altered. Microscopic examination showed the distal portion of the protruding end of the lower fragment to be entirely devoid of living bone and there was lacunar absorption in places along its surface. Its base, however, which lay within the field of the functioning bone was composed of living bone which had slowly grown in and replaced the dead bone.

This specimen illustrates in a striking way the influence on the rate of absorption of the dead bone and its replacement by new bone brought about both by function and by radium injury of the adjacent living bone. After healing of the fracture, the necrotic lower end of the upper fragment fell in the new line of stress and strain of the angulated bone, while the necrotic end of the lower fragment fell almost entirely outside of it. The necrotic end of the upper fragment was rapidly replaced by new bone while that of the lower fragment was little changed, as shown by Figures 8, 9 and 10. An important factor in the rapid transformation of the necrotic lower end of the upper fragment was the type of callus about it. Most of the new bone uniting the fracture and coming in contact with the overriding fragment of dead cortex had its origin from the anterior surface of the shaft of the lower fragment *below* the field that was damaged by radium. It should be expected that callus arising from healthy bone would more rapidly replace the necrotic portion than would that arising from the radium-damaged living bone at the margins of the dead bone.

In *two* experiments remaining free from infection about 4 cm. of the shaft of the femur was killed by inserting 25 mg. of radium upward and 25 mg. downward from a hole cut in the side of the cortex, and leaving it for twenty-four hours. In each the bone was subsequently fractured through the necrotic portion and non-union followed so that the entire bone was thrown out of function, the animal carrying the limb in walking. The influence of non-use was observed upon the changes in the dead and living bone.

In a 58-day experiment the bone was fractured twenty days after the radium exposure, and on dissection of the limb thirty-eight days later the two fragments were found over-riding and ununited with about 2 cm. of each necrotic end bare. At the base of each necrotic end, but most marked on the upper, there was an irregular groove from absorption by granulation tissue, representing the early stages of sequestration.

Fig. 7. Necrotic segment, x, eighty-six days after irradiation.

In a 720-day experiment the bone was fractured twenty-five days after the beginning and non-union continued. A roentgenogram taken at the end of five months showed the fragments over-riding with a long necrotic piece attached to the upper end and a short one to the lower fragment.

A second roentgenogram at the end of a year showed non-union and complete sequestration of both necrotic ends, with some evidence of absorption of their distal portions. When the animal was sacrificed there was fibrous union of the rounded ends of the over-riding angulated and atrophic fragments. The upper sequestrum was surrounded by fibrous tissue and considerably worm-eaten and reduced in size, as shown roentgenographically in Figure 12. The lower sequestrum had been absorbed.

These two experiments show that when the aseptic dead bone does not function it is sequestrated and slowly absorbed.

In one 45-day experiment and another 75-day experiment the entire thickness of soft parts overlying the irradiated bone on one side became necrotic, and suppurative infection of the bone resulted. The bones were not fractured and the animals walked on the limbs. In the 45-day experiment sequestration of the necrotic bone had begun, and in the 75-day experiment it was about half complete. There was no sign of creeping replacement of the dead bone by new bone. These experiments show that in the presence of suppurative infection, bone that is killed by radium is gradually sequestrated even when there is no fracture through it and it continues to support the part in walking.

Fig. 8. Fig. 9.

Fig. 8. One hundred and fifty-four days after irradiation, and fifty-four days after fracture; *a* and *b* are necrotic ends of upper and lower fragments.

Fig. 9. Two hundred and fourteen days after irradiation. Necrotic end, *a*, of upper fragment lying in line of functioning bone has been largely absorbed and replaced by new bone, while *b* lying outside, shows little change.

CLINICAL OBSERVATIONS

In 3 persons under treatment for sarcoma four to eight buried radium needles, each

containing 12.5 mg., were left in contact with bone in an aseptic field for fifteen to twenty hours, i.e., sufficiently long to produce necrosis, and the results observed by means of roentgenograms over periods of twenty-two, forty-six and twenty-three months respectively. The 22-month case was a round cell sarcoma of the right

FIG. 10. Roentgenogram of specimen removed 537 days after irradiation; *a*, entirely replaced by new bone; *b*, partly absorbed at upper end and partly replaced by new bone at its base.

subdeltoid region of five months' standing in a woman aged thirty-five. One month after massive roentgen-ray treatment the tumor was excised locally and eight 12.5 mg. needles implanted for fifteen hours, four or five needles being in contact with the humerus. There was no recurrence twenty-two months later, and frequent roentgenograms showed no evidence of sequestration of bone in the irradiated regions. The 46-month case was a round cell sarcoma of the lateral supracondylar region

FIG. 11. Sagittal section of specimen: *a*, new bone replacing dead end of upper fragment; *b*, dead end of lower fragment.

of the right arm in a woman aged forty-six. One week after heavy roentgen-ray treatment it was excised locally and was found to lie in contact with the surface of the humerus. Eight 12.5 mg. needles of radium were implanted for fifteen hours; four of the needles lay close together and in contact with the humerus. Forty-six months later there was no local recurrence but a small regional recurrence near the axilla. Roentgenograms taken at six to eighteen months' intervals showed no sequestration of bone but definite structural changes in the irradiated area as evidence of creeping replacement of the dead bone by new bone.

The 23-month case was that of a moderate-sized, slightly ossifying osteogenic sarcoma of the ischium in a woman aged fifty-five. It was first treated by the implan-

tation of sixteen 12.5 mg. needles of radium for twenty hours. Many of the needles were felt to come in contact with bone. This was followed by roentgen therapy over a period of six months. The tumor disappeared and the ischium, which at first showed considerable bone destruction, reossified, as shown by repeated roentgenograms taken during the succeeding twenty-three months. There was no evidence of sequestration of the scattered islands of bone killed by the radium.

FIG. 12. Roentgenogram of specimen from 720-day experiment. Radium necrosis of 2 inches of shaft of femur. Fracture through necrotic segment on 25th day remained ununited and limb did not function. Dead bone sequestrated. Upper sequestrum, *a*, partly absorbed, lower one completely absorbed; *b*, sesamoid bone.

An osteogenic sarcoma of the sternum in which there was considerable ossification was treated for twelve hours with 150 mg. of radium inserted in needles which penetrated tumor bone. The specimen obtained two months later at autopsy showed areas of necrotic bone and tumor in the irradiated regions, but there was no sign of sequestration of the dead bone.

CONCLUSIONS

1. Uninfected necrotic bone produced by the implantation of radium is disposed of differently according to whether or not it functions mechanically in the support of the part.

2. If an entire segment of the femur or humerus of a dog is killed and subsequently used in weight bearing, the dead bone will not be sequestrated, but will slowly undergo creeping substitution by ingrowing new bone.

3. If it is not used, as a result of non-union of a fracture through it, the necrotic bone will be sequestrated from the living bone and very slowly absorbed.

4. Because of the radium burn of the adjacent bone and soft parts, the rate of creeping substitution by new bone or of absorption is much slower than in the case of aseptic necrotic bone, the result of circulatory disturbance or of the application of chemicals.

5. Secondarily infected areas of bone killed by radium undergo sequestration, whether or not they function mechanicaally during the period of sequestration.

6. Bone killed by radium in the treatment of tumors is gradually replaced by new bone if it remains free from infection and functions in the support of the part.

7. When a small necrotic portion borders on an articular surface, it does not become detached and go free into the joint as a joint mouse.

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STUDIES ON THE EFFECT OF ROENTGEN RAYS ON GLANDULAR ACTIVITY. V. THE EFFECT OF ROENTGEN RAYS ON EXTERNAL PANCREATIC SECRETION*

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SINCE the pancreas produces a very important external and internal secretion, and since roentgen rays are being directed into the upper abdomen for therapeutic purposes, it is important to know the effect of various doses of roentgen rays on the functions of this vital organ.

During the course of our observations on the effect on gastric secretion,[1] of exposure of the abdomen to roentgen rays we found that a marked fibrous atrophy (weight of pancreas 4.4 gm.) of the pancreas resulted in one animal which had received approximately one human erythema dose of hard roentgen rays. This animal had manifested steatorrhea prior to death and the bladder urine contained a small amount of sugar. In another dog an approximately 50 per cent fibrous atrophy was found at death, but the urine contained no sugar (not heretofore reported).

Since in these animals other tissue than the pancreas was exposed, we could not conclude whether the injury was caused by the direct effect of the roentgen rays on the pancreas, or resulted secondarily from the effect of the roentgen rays on other tissues. This being the case, it was necessary for us to devise methods whereby the pancreas could be exposed without at the same time exposing other tissues.

METHODS

Because of the shape and location of the pancreas in the dog, it is impossible to expose all the pancreas and to shield other organs.

In 6 animals we attempted indirectly to follow pancreatic secretion by feeding fat and analyzing the feces for fat before and after exposure of the pancreas directly to roentgen rays during an aseptic operation, the head and major portion of the body of the pancreas having been removed at a previous operation. This method we found to be unsatisfactory because too many uncontrollable factors were present.

We had purposely avoided the use of pancreatic fistula animals, in which the secretion could be quantitatively and qualitatively followed, because in such animals the pancreas alone could not be exposed to roentgen rays. However, it occurred to us that the tail of the pancreas might be transplanted under the mammary gland in such a manner that its secretion could be collected and that it could be exposed to roentgen rays without at the same time exposing other organs.

The tail of the pancreas was transplanted under the mammary gland of 6 dogs as shown in Figure 1.

After a sufficient number of control responses to a standard meal (300 gm. meat, 50 gm. bread, and 150 c.c. milk) had been obtained, the animals were operated on aseptically, a lead plate slipped inside the abdomen beneath the transplanted pancreas, and a lead plate with a rectangular opening 4 by 7 cm. was placed over the transplant outside the abdomen in such a manner that only the transplant and the surrounding skin and tissue were exposed to the roentgen rays.

The following technique was used in all experiments: 150 kv., 5 ma., 0.5 mm. Cu plus 1 mm. Al, 35 cm. focal skin distance, 7×11 cm. portal, the effective wave length being 0.181 Å.

All the tissue of the transplant can be considered as being exposed to the roentgen rays because of their hardness and the thinness of the transplant.

Dog "S" received 27 ma-min., which is approximately one-tenth of a human

* Read at the Twenty-seventh Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Detroit, Mich., May 17–21, 1926.

erythema dose; dogs "P", "F", and "O" received 134 ma-min., which is approximately one-half a human erythema dose; and dogs "E" and "Em" received 260 ma-min., which is approximately one human erythema dose.

Since the animals recovered promptly—ate the next day—, and since there was no disturbance of digestion secondary to withdrawal of pancreatic secretion, the principal portion of the pancreas still functioning in normal position, any effect observed can be ascribed only to the effect of the roentgen rays on the pancreatic tissue or the tissue immediately surrounding it.

The secretion was collected by a glass funnel attached to the skin by celloidin.

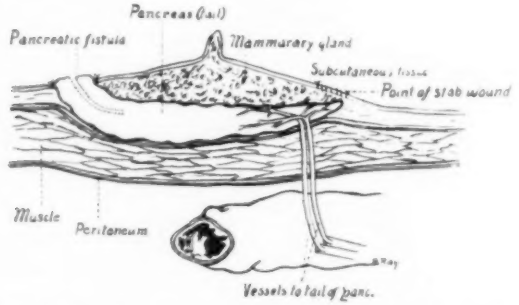

Fig. 1. Drawing showing method of transplanting tail of the pancreas under the mammary gland.

The secretion was collected for six hours after a meal.

The lipase content of the secretion was determined by the ethyl butyrate method and is expressed in the tables as clinical units of acidity developed. The trypsin content of the secretion was determined by the formalin method and is expressed in the tables as cubic centimeters of N/10 NaOH required to neutralize the acidity developed. One-half c.c. of juice was used for each determination.

It must be kept in mind that this secretion contains inactivated enzymes. We activated the trypsinogen with enterokinase.

RESULTS

The results that have been obtained up to the present time are shown in Tables I, II and III.

At this point it should be stated that only changes of more than 0.1 per cent acidity (25 clinical units) in the lipase determinations and of more than 2 c.c. in the trypsin determinations can be considered significant. This is due to the normal physiological variation and of course varies in different animals.

Attention should also be directed to the fact that a gradual atrophy of the pancreatic transplant does not occur provided the fistula does not close. This statement is based on our experience with over 12 such animals that we have observed almost daily for over a year.

One-tenth Erythema Dose. In dog "S," which received approximately one-tenth of a human erythema dose, the secretion was not changed in quantity for twenty days after the exposure; but the lipase content was slightly increased, and the trypsin content was definitely increased (Table I).

One-half Erythema Dose. The results show (Table II) that one-half an human erythema dose caused an increase in the quantity of the secretion during the first fourteen-day period following the exposure. Two of the animals were secreting more juice than normal forty-six and thirty-eight days after exposure, but the other one at twenty-seven days was secreting less than normal.

The lipase concentration was not materially affected during the first fourteen-day period following exposure. At forty-one and thirty-seven days in the 2 dogs that still showed an increase in quantity, the lipase was definitely increased. Whereas, in the dog that showed a decrease in quantity, the lipase was normal.

The trypsin concentration in the secretion of one animal remained the same, while in the second animal it was decreased for six days and then returned to normal. In the third animal it remained normal for fourteen days and then was definitely increased. In this case, however, it will be noted that the secretion was decreased in quantity, the total quantity of trypsin produced being approximately the same as normal.

One Erythema Dose. The results show (Table III) that one erythema dose caused a definite decrease in the quantity of

TABLE 1

SECRETION BEFORE AND AFTER EXPOSURE TO ROENTGEN RAYS

One-tenth Human Erythema Dose—Dog "S"

	Days after Exposure	Amount in C.c.	Lipase Content	Trypsin
		Control Responses before Exposure		
		1.6	75	6.6
		2.5	45	5.7
		2.5	55	5.5
		2.3	95	5.0
		2.4	62	6.0
Average	..	2.46	66	5.7
		Response after Exposure		
	1	1.3	105	12.3
	2	2.3	62	11.2
	4	2.5	100	10.0
	6	2.8	62	8.0
	7	1.7	80	9.0
	8	2.5	102	9.0
	9	2.5	100	8.0
	12	2.5	87.5	5.5
	13	3.0	50	9.5
	14	2.8	125	11.5
	15	2.8	112	12.0
	20	2.0	100	11.0
Average	..	2.4	90	9.7

secretion in both animals. In dog "E" it appears as if the secretion has again returned to normal at forty-seven days.

The lipase concentration of the secretion was not materially affected in either dog.

The trypsin concentration was definitely increased in the secretion of dog "E," being noticed first fourteen days after exposure. In the other animal the concentration appears to be slightly increased. However, if one calculates the total trypsin output from the third averages and compares it with the first or normal average, it is found that the decrease in secretion accounts for the increase in trypsin concentration.

DISCUSSION

We have observed marked fibrosis of the pancreas in 2 animals following the exposure of the abdomen to one human erythema dose of roentgen rays. Kmietowicz and Tumidajski[2] observed a decrease in the pancreatic secretion after the administration of 2.8 human erythema doses given in three doses within five weeks (May 19, ⅓ H.E.D., 3 mm. Al; May 21, 1.0 H.E.D., 3 mm. Al; June 26, 1.5 H.E.D., 3 mm. Al). Fisher, Groot and Bachem[3] have seen marked fibrosis of the pancreas after exposure to three human erythema doses, and complete disappearance after four or five erythema doses. In this study we have seen a depression of pancreatic secretion after exposing pancreatic tissue to one human erythema dose. In the case of dog "O," Table II, in which the pancreatic tissue was exposed to one-half a human erythema dose some depression of secretion occurred after a primary increase. These facts taken together strongly suggest, if they do not prove, that the pancreas is quite variable with reference to its response to roentgen rays.

The fact that the secretion returned to normal in dog "E" forty-seven days after one erythema dose can be easily accounted for by the regenerative power possessed by the pancreas. Fisher, Groot and Bachem observed anatomical evidence of regeneration in the pancreas of their dog thirty days after exposure. This regenerative power of the pancreas has been demonstrated by the work of Fisher,[4] Grauer,[5] and others.[6] This is the redeeming feature of the susceptibility of the pancreas to the deleterious action of roentgen rays and is of great importance because of the vital nature of the functions of this organ.

The fact that one-half a human erythema dose causes a definite and rather prolonged increase, at least in 2 dogs, of the quantity of the secretion without decreasing the output of enzymes is exceedingly interesting to us as well as quite significant. It is the first evidence that we have obtained in our four years of study which might be interpreted as showing that roentgen rays directly stimulate a secretory process. However, we do not believe that our experiments have progressed sufficiently to warrant a definite interpretation of this phenomenon.

Kmietowicz and Tumidajski[2] have reported that irradiation activates proferments and at the same time decreases the quantity of juice. Since they do not give the amounts of juice collected, they do not prove their interpretation of their observation. The evidence presented in Table I on the effect of one-tenth of an

TABLE II

SECRETION BEFORE AND AFTER EXPOSURE TO ROENTGEN RAYS

One-half Human Erythema Dose—Dogs "P" "F" and "O"

Days after Exposure			Amount in C.c.			Lipase			Trypsin		
Dog "P"	"F"	"O"	Dog "P"	"F"	"O"	Dog "P"	"F"	"O"	Dog "P"	"F"	"O"
			Control Responses before Exposure								
			4.5	3.8	5.5	125	145	87	7.2	14.4	4.0
			6.5	3.1	5.0	82	165	127	7.7	13.0	9.0
			5.5	3.0	3.5	80	200	137	9.0	11.5	7.0
			5.0	4.0	...	120	165	...	7.5	10.5	
			5.0	3.5	...	112	200	...	7.0	12.0	
			5.0	...	...	105	...	...	8.5		
Average			5.25	3.48	4.66	104	175	117	7.8	12.3	6.66
			Response after Exposure								
1	1	..	7.0	3.4	...	125	187	...	9.0	4.0	
2	2	2	4.0	9.5	6.2	140	225	75	6.5	4.0	6.5
4	3	..	8.0	8.7	...	100	250	...	7.5	5.0	
6	4	5	10.0	6.5	8.0	75	162	105	7.0	7.0	6.2
7	7	6	7.7	3.5	10.0	100	200	150	6.0	10.0	8.6
8	8	8	7.5	6.0	6.0	102	137	150	10.0	18.0	5.0
9	9	10	7.5	8.0	5.0	75	225	125	8.5	7.0	8.5
13	..	11	9.5	...	4.7	150	...	125	7.0	....	3.0
14	..	12	9.0	...	2.5	150	...	100	6.5	....	3.2
Average			7.8	6.3	6.0	113	198	118	7.55	7.85	5.8
16	..	..	8.0	...	...	150	...	...	6.0		
17	17	..	4.5	6.5	...	100	215	...	4.5	11.7	
18	..	18	8.5	...	3.5	250	...	65	7.0	....	12.0
19	19	19	9.5	6.0	2.5	175	265	100	7.0	7.0	11.5
27	21	20	6.0	4.5	3.5	175	175	107	10.0	14.0	13.0
29	22	..	9.5	5.5	...	215	265	...	6.0	16.0	
31	23	25	7.0	...	2.7	225	...	112	9.0		
32	29	26	5.0	5.0	4.0	212	187	117	9.0	12.0	10.5
33	30	27	8.0	5.5	3.0	210	230	105	8.4	10.0	12.0
34	31	..	8.2	4.5	...	130	182	...	9.0	12.0	
39	36	..	7.5	4.0	...	175	250	...	4.5		
41	37	..	9.0	4.3	...	180	300	...	11.0	12.5	
Average			7.5	5.1	3.2	183	230	116	7.6	12.0	12.0
46	38	..	5.5	5.0	...	137	200	...	....	14.0	
47	..	..	8.0	...	...	100	...	...	16.5		
48	..	..	7.5	...	...	137	...	...	14.0		

erythema dose supports their interpretation, especially since the quantity remained the same and the enzyme content increased after exposure. However, one experiment is not sufficient to prove this point. We have other experiments under way.

SUMMARY

The effect of three different doses of roentgen rays upon the secretion of the pancreas has been studied in dogs prepared with a chronic fistula of a portion of the pancreas so placed that it alone was exposed to the action of the roentgen rays.

In one experiment one-tenth of a human erythema dose increased the concentration of lipase and trypsin, but did not affect the quantity of the secretion. In 2 animals one-half of a human erythema dose increased the quantity of the secretion and the total output of ferments. In a third animal this dose increased the quantity of secretion and total output of ferments the

TABLE III

SECRETION BEFORE AND AFTER EXPOSURE TO ROENTGEN RAYS

One Human Erythema Dose—Dogs "E" and "Em"

Days after Exposure		Amount in C.c.		Lipase		Trypsin	
Dog "E"	Dog "Em"	Dog "E"	Dog "Em"	Dog "E"	Dog "Em"	Dog "E"	Dog "Em"
		Control Responses before Exposure					
		7.0	6.0	92	110	8.0	9.0
		6.5	6.5	100	162	9.7	5.0
		6.4	6.0	65	165	6.0	6.0
		6.0	...	75	...	9.0	
		6.0	...	125	...	8.0	
		5.0	...	137	...	9.5	
Average		6.1	6.1	99	145	8.0	6.6
		Responses after Exposure					
1	2	4.5	...	157	...	4.2	
3	2	3.0	9.0	100	180	7.0	3.5
5	5	1.5	4.0	62	80	7.0	3.6
6	6	5.5	4.0	175	145	6.0	8.2
7	8	6.0	7.5	100	125	6.0	5.0
8	10	4.0	5.5	75	125	8.0	9.0
12	11	2.0	4.5	75	160	11.0	6.5
13	12	5.2	3.0	150	150	10.3	3.2
14	..	2.7	...	100	...	13.0	
Average		3.8	5.3	110	138	8.0	5.5
18	17	4.2	6.7	62	142	13.5	8.3
19	18	5.0	6.5	100	162	17.0	5.0
20	19	3.0	3.5	175	120	7.0	7.0
28	24	4.5	6.0	75	150	9.0	
30	25	6.0	4.0	150	112	5.5	11.0
32	26	5.6	3.0	200	112	11.0	9.0
34	..	4.0	...	175	...	9.0	
39	..	4.2	...	90	...	13.5	
41	..	1.7	...	120	...	15.0	
42	..	3.0	...	82	...	12.0	
Average		4.0	4.9	122	133	11.2	8.0
47	..	7.5	...	125	...	15.0	
48	..	8.5	...	150	...	11.5	

first week after exposure, following which the quantity of secretion and the total output of lipase was decreased and the total output of trypsin remained normal. One human erythema dose decreased the quantity of secretion and total output of ferments in 2 animals for two weeks after exposure. One animal returned to normal forty-seven days after exposure, the total output of ferments being greater than normal. It has been pointed out that although the pancreas may be temporarily injured by one human erythema dose its power to regenerate may compensate for the injury.

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DISCUSSION

Dr. H. P. Doub, Detroit, Mich. I should first like to express my appreciation to the essayists for the beautiful manner in which they have conceived and carried out these experiments. I think it is such experiments carefully carried out and checked in this manner which will help in determining the effects of irradiation in the various parts of the body. I believe that a knowledge of the functions of the various organs will be gained by such studies. In the past a great many experiments have been recorded on stimulating doses and on destructive doses of irradiation. These same experiments have been repeated by other authors with entirely different results.

I believe that this set of experiments tends to confirm the oft-repeated statement that small doses of radiation stimulate and large doses depress. This statement has been argued pro and con and I believe that such experiments as this will help to clarify the situation. I myself would think that this lends weight to the statement that small doses do stimulate the secretion of organs. I think that is possible. I would leave out the stimulation of cancer; I would not want to enter into that discussion because I have never seen any evidence to support it.

We have for some time been interested in subjects of this type. We haven't done any direct work on the pancreas itself but in treating other abdominal organs we have incidently covered the pancreas. I could confirm all of the pathological changes which they report. We have found in some of our animals which received irradiation over a portion of the pancreas marked fibrosis, also marked fat necrosis. We have also found regeneration of the tissues in this as well as in other abdominal organs, and I believe Dr. Orndoff has stated that this is a saving grace in the therapy over the abdominal organs. If these organs did not regenerate and if they were not supplied with excessive tissue to begin with, we would not dare give the dosage over the abdomen which we do.

Dr. A. C. Ivy, Chicago. We did our work on the submaxillary and the gastric glands with much greater ease than we have done this work on the pancreas. Much more is known concerning the physiology of gastric secretion than of pancreatic secretion. The reason for that is that the methods for studying gastric secretion are much more simple than the methods for studying pancreatic secretion.

You have noted that we had to devise a special method for studying the external secretion of the pancreas before we could satisfy ourselves as to the effect of roentgen rays upon this organ.

I would just like to disagree with the statement that Dr. Doub made in that it is too general, namely, that this shows that organs can be stimulated by roentgen rays. Those of you who are familiar with our work I think will be satisfied that we have demonstrated that the submaxillary gland and the glands of the stomach cannot be stimulated by roentgen rays. We have strong suggestive evidence that the glands of the pancreas that secrete pancreatic juice can possibly be stimulated. We are not yet through with this problem; we have just begun, after spending about a year on the development of a satisfactory method.

Dr. Masao Tsuzuki, Tokyo, Japan. I would like to ask Dr. Orndoff if he recognized any histological change in the parts of the pancreas which remained in a normal position?

Dr. Ivy. The part that remained in its normal position was perfectly normal. There was no change, and in the transplant itself, that is, after we cut the pedicle, which we have not done in this work, but in other work, to prove that a hormone is concerned in external pancreatic secretion, there was about a 50 per cent atrophy of the transplant, but, nevertheless, there is still sufficient acinar tissue to form rather large quantities of external secretion, and there is also sufficient material to take care of the sugar metabolism of the animal when the remainder of the pancreas is removed, so we have here a method of experimentally preventing diabetes in dogs.

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THE RÔLE OF ROENTGENOLOGY IN MEDICAL EDUCATION*

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THE INFLUENCE OF ROENTGENOLOGY

IN 1530 within the shadow of the Studium or University at Ferrara, even then nicknamed by the ribald the Asylum of the Destitute, Berengar of Carpi started out upon the long journey of the dead. Here was the passing of the old order of anatomists. It was succeeded by men fired by a new ardour, Canano, Servetus, Vesalius, men who were not content with quartering the body, men who insisted upon flaying the cadaver and dissecting in detail, rather than verifying authoritative writings handed down by tradition.

"I have made very little comment on the muscles of the body," writes Berengar. "I have concerned myself very sparingly with this system; mainly for the reason that, in the ordinary dissections made before the scholars in the schools, the majority of the muscles cannot be demonstrated. In order to expose properly these structures to view, extremely long and painstaking labor is required as well as a suitably appointed room."

This episode is characteristic of the history of science and particularly of the "science of the sepulchre" of which I have the honor to be an exponent, and it is particularly opportune to recall it in connection with him in whose name this lecture is established. For we are even now passing through a similar phase and Caldwell clearly foresaw that roentgenology holds the spark which should kindle anew into flame the fitfully smouldering science of anatomy.

It is then my pleasure and duty to acknowledge the inspiration which the mother of medical sciences has received from her youngest daughter, Roentgenology.

In this address, although my mind runs upon the play of roentgenology upon the entire gamut of the medical curriculum, my words for obvious reasons must be largely confined to the inter-relationship of roentgenology and anatomy. I am not aiming to consider the problem, important enough in practice, it is true, whether or not roentgenology should be a separate course in the medical curriculum: that, I take it, is a matter for decision by convenience and local conditions. No science which has contributed so much as yours has to medical study and investigation, can confine its influence. The leaven is apparent through the entire curriculum. Once a school has felt its quickening influence there is no department but must speedily share in its benefits. In our own school it happens that Anatomy is first equipped. Already in two years the service has become too onerous for one laboratory to fulfill and it is now decided to equip Pathology in similar fashion. If you ask me when instruction by roentgenographic methods should commence, I reply, in the anatomical laboratory on the first day of the medical course. Our students are assigned their place in the dissecting room and within ten minutes after this the directions for the barium meal examinations are posted.

ANATOMY OF THE LIVING

Twenty and more years ago, when the roentgenographic equipment was first installed at Manchester Royal Infirmary under the direction of Dr. A. E. Barclay, we had some rude shocks to our ideas regarding the stomach—an experience which many of you have shared, although our imperfect operating room conceptions of the stomach have been so long discarded that it is quite an effort to recall them. I had the good fortune to be associated with Dr. Barclay and I have a vivid recollection of vigorous surgical diatribes against the roentgenographic reports. Now when the student first enters his medical course his

* Caldwell Lecture, 1926.

notion of the stomach is still the preroentgenographic one. Beaumont's researches still form the basis for lower school teaching. The stomach is still a "sac" and the chief site of "digestion." Without the roentgenoscopic examination there is little in anatomy to force a change in his ideas. Textbooks do not help for authors are as yet unwilling to make a clean break with traditional teaching though they have been compelled to recognize the changed conceptions brought about by roentgenographic methods. In consequence, the anatomical description of the stomach has become more bewildering than ever.

It is unnecessary to multiply instances. Quite recently the work on lungs and gallbladder, to mention only two lines of investigation, have brought new light and new vigor into our study of the organs of the body. Roentgenographic methods have been the chief factor in changing the character of an up-to-date anatomical course which should rightly be a description of the quick, not the dead.

It is interesting to note how effective this factor has been. Even the profound influence of Mall and his school could not awaken Anatomy from its lethargy. Great as were the influence of histological study and embryological reconstruction, these served rather to thrust Anatomy further away from practical medicine. Some years ago Sir Arthur Keith lamented to me in a letter: "The physiologists have stolen our thunder while we were wandering in the wilderness of comparative anatomy." Roentgenology is bringing anatomy back into her own.

Yet so heavy is the hand of tradition that we escape with difficulty. We have not yet fully realized, for example, how profound a change is upon us in our notions of epiphyseal union. The last anatomist to work genuinely upon this subject was Henle of Goettingen about the middle of last century. Current descriptions still are based on the stray observations of occasional investigators upon material the age of which is indifferently recorded. If roentgenologists will be bold we shall have great simplification of this subject.

There is no more instructive sight for the student than the joints moving on the roentgenoscopic screen: it gives a new zest to the dissection of these parts, almost totally neglected under ordinary circumstances.

THE MEDICAL STUDENT AS A SUBJECT

The medical student as a member of the medical profession is, or should be, keenly interested in the progress of medical study and investigation. He may therefore be justifiably asked to cooperate in the work being carried on by his instructor. But it is the responsibility of the instructor to respect this willingness. The student should never be asked to submit to any procedure which has not been carefully thought out or has not been participated in by the instructor to the full extent to which the student is asked to cooperate. While I firmly believe that no man is fit to become a physician unless he is willing to adventure his body in the cause of his profession, I make it a rule to call upon my students only after it is obviously impossible for myself to continue as the subject of the investigation. Any risks must be fully and carefully explained beforehand and the agreement put upon a perfectly voluntary basis, care being taken to demonstrate that there is no discrimination between those who desire to serve and those who do not.

The student is emphatically not an individual on whom to try experiments of an imperfectly understood nature. I have never had the slightest difficulty in getting sufficient volunteers. For roentgenoscopic examinations I find four students the maximum for efficient work and two of these volunteer to serve as subjects: the spirit of professional fellowship may be depended upon to bring forth two subjects, for were there but one volunteer, he himself would be penalized because he cannot look at his own roentgenoscopic image.

THE PSYCHOLOGY OF DARKNESS

Man is not naturally a nocturnal animal and it is quite reasonable to suppose that the excitement of a strange environment, the proximity of so potent and imperfectly understood an agent as the roentgen ray, together with the unaccustomed darkness, react powerfully upon the

human organism. While it is undoubtedly true that many persons show no effect whatever either in pulse rate or tone of viscera, some individuals are powerfully stimulated. The behavior of the student betrays the condition of his nervous sytem. I have seen an apparently normal man giggle uncontrollably while feeling for his iliac crest. The giggling then spread to the other three who were watching him. Girl subjects are still more strikingly affected. Usually in such a state the pyloric vestibule lies low down and the peristaltic waves in the stomach are slow in commencing and in rhythm.

I am not convinced that the response of the stomach is proportionate to the amount of food. The organ as it were, lets out tucks in its walls: it distends suddenly by jerks. The number of these jerks and the amount of increase in volume vary from student to student and they are more marked in the freshman than in the sophomore. I feel strongly that there is a nervous factor in these phenomena. Between the freshman and sophomore years there is a distinct difference in position of pylorus, of greater curvature and to a less extent of the cardia, these parts being higher in the sophomore. It looks as though familiarity with the methods of roentgenography exercises an effect upon the organ. So far we have not investigated the bowel from this point of view.

The student becomes keenly interested in the roentgenograms taken after his barium meal. Sometimes we find a stomach photographed devoid of peristalsis. At first we thought this was merely an accident, the organ having been caught between the passage of two waves of peristalsis. But serial roentgenography indicates that this interpretation may not be correct: there may indeed be temporary inhibition of peristalsis while the roentgenogram is being taken. Now if the sophomore student, examining the series of roentgenograms taken of himself after his freshman and sophomore barium meals, discovers that there is good peristalsis in the former and not in the latter series he is apt to become agitated and depressed. Sometimes he needs much reassurance. Usually, however, the stomach is much more normal in tone at the beginning of the sophomore year.

The light thrown by these observations on roentgenographic pictures of patients is obvious.

ADEQUATE RECORDS OF THE NORMAL

From what has been stated it is plain that the student speedily realizes that his cooperation is of immense value in the systematic teaching and research of the laboratory. I know of no way in which the practical object lessons of medical study can be so efficiently and quickly brought home to the student body.

Further, since all the records are made upon normal healthy young adults, the value of the standards thus established is very great indeed. The records constitute a library of living anatomy which the medical school should take pride in forming. Anatomical laboratories have not yet realized their responsibility to the profession in this matter. The laboratory of the future, in my opinion, will be the place to which physicians will regularly resort as they now go to the medical library.

APPLICATION TO SPECIAL SYSTEMS

The anatomical laboratory is the only place where systematic roentgenographic work upon the living and upon the dead can be carried out side by side. Nor indeed is the one complete without the other. In the dead the proteins of the body are coagulated and offer a penetrability to roentgen rays different from that of the living. Embalming still further enhances this difference. Thus it is possible to obtain roentgenographic pictures of muscles, tendons, cartilage and joint cavities in the embalmed subject which cannot be hoped for in the living. It is also possible to use long exposures with low milliamperage in the dead, and thus to bring out features necessarily obscure in the living. Therefore roentgenology comes to have many unforeseen applications in anatomical study. The student's training becomes broad and comprehensive, for he shares in the opportunity of seeing roentgenographically such things as the results of artificial production of pneumonia in laboratory animals, the effects of low calcium

or low phosphorus diet upon the growth of bones. I regard the anatomical laboratory as the place where the student is introduced to normal structure, it is true, but also to deviations from the normal, thus clinching his appreciation of what properly formed and functioning organs should look like.

Of all the systems the genito-urinary is the least fitted for roentgenographic study. Of course it is possible, by making a suprapubic incision, to catheterize the ureters. I have not succeeded in catheterizing them through the cystoscope in the cadaver, for the bladder is toneless and simply distends on injection of water without losing the folds obscuring the back of the trigone.

In examination of living lungs we have found estimation of size of trachea and bronchi extremely difficult and uncertain. It may be that Forestier's method will give us the opportunity to study these passages in the various phases of respiration. So far, however, we have been unconvinced of the value of Macklin's results.

For the vascular system, examination of the cadaver is quite helpful. One can frequently make out the pericardium as a distinct covering to the heart.

In the locomotor system we find a cadaver kept for several years of immense value, for the joint cavities lose their fluid and become filled with gas, thus rendering them as intelligible as the gall-bladder when air is injected into the peritoneum.

The alimentary canal has already been touched upon. It remains merely to add that we have been able to study by serial roentgenography the normal and spastic colons, details of which must be left for description to another occasion.

ADJUNCTS OF THE ROENTGENOGRAM

In using roentgenography for medical instruction there are two applications which greatly enhance its value. These are, first the stereoscope with stereoscopic projection and secondly, the moving picture.

Stereoscopic roentgenograms are necessary in many cases and yet one cannot give these valuable originals to students for they would soon be spoiled. Again they are large and cumbersome and the roentgen-ray stereoscope is much too expensive to warrant the purchase of enough for study purposes. It is however perfectly possible to reduce the stereoscopic pair to small films or plates $3'' \times 3''$ and set them up as a stereoscopic transparency for use in a hand stereoscope.

For eight years we have used stereoscopic projection of anatomical photographs and are at present engaged in trying to modify this for the projection of roentgenograms. The method is simple but the application to roentgenographic projection is not easy. Briefly a pair of lantern slides photographed stereoscopically, are placed in a double lantern, the one slide being projected through a red filter, the other through its complementary green filter. The observer looks at the double image through a pair of spectacles of which one glass is red and the other green. The green eye picks out the green image; the red eye picks out the red image. Synthesis of these two images takes place in the cerebrum and the resultant picture seen in perspective is devoid of color. Until such time as this method is perfected for roentgenograms, the hand stereoscope must suffice.

The moving picture has of course been employed for some time by Cole. It has proved a fascinating technique to the students and there is no difficulty in getting their cooperation. A team of six including the subject is necessary to get serial roentgenograms. Once the serial roentgenograms are taken the remainder of the work is not difficult, though laborious. A Sept cinematographic camera is mounted permanently in front of an illuminated ground glass screen on which the roentgenograms may be photographed in turn. This screen must be movable vertically, laterally and round an axis passing at right angles to the screen through the center of its lower margin. By means of adjustable markers the roentgenograms are mounted successively in exactly the same position and photographed on to the standard sized film. The standard size positive gives the best pictures but substandard positives can be made, thus greatly reducing the cost, with

but slight deterioration of the pictorial effect. Since the non-inflammable film becomes brittle in about a year and hence untrustworthy it seems likely that the substandard size positive will become the popular medium of exhibition. The equipment can be installed at very little cost and the method opens up a new and extremely valuable means of approach to the study of living anatomy and pathology.

Institutions are slow to take up new methods of presentation but once the roentgenographic method with its accessories thoroughly enters the consciousness of medical teachers there is no doubt of its permanency and usefulness.

Anatomy has been passing through a Winter of neglect but under the quickening influence of Roentgenology will shortly burst forth once more into Spring. As Hardy has said in a well-known passage, "Winter which modifies the note of such trees as shed their leaves, does not destroy its individuality."

PRESENT PROBLEMS IN DEEP ROENTGEN-RAY THERAPY

BY ROBERT E. FRICKE, M.D.

BALTIMORE, MARYLAND

THE science of roentgenology has advanced with astonishing rapidity since the discovery of the mysterious ray by Röntgen in 1895. Roentgenography has improved immeasurably with the perfection of technique, exemplified by the introduction of intensifying screens, grid diaphragms, sensitive films, and the use of non-toxic opaque media in body cavities. Replacement of the gas tube by the Coolidge hot-cathode tube, introduced in 1913, marks an important milestone in both roentgenography and roentgen-ray therapy. Better control and reliability are features of the hot-cathode tube; voltage and current can be altered independently of each other, and the focal spot no longer tends to vary in size or position. Along with the development of the roentgen-ray tube the construction of closed-core, oil-encased transformers afforded equipment which could function continuously in treatments at 200,000 volts and 4 or 5 milliamperes.

Another important milestone in therapy is noted when Coolidge[1] perfected a water-cooled tube in 1923. With this apparatus we command a higher voltage, insuring greater depth dosage, and also a much higher milliamperage serving to shorten exposures, thus making treatment more endurable to patients and (as we have found) decreasing radiation sickness. Personal experience with the water-cooled tube in over 300 cases, now under review, has proven most gratifying in immediate results.

The present problems in deep roentgen therapy are questions of dosage. As with all new drugs or forms of therapy, dosage is still inexact and just emerging from the empirical stage. Until recently, the energy input of a machine was the only standard of measurement. In reviewing a treatment, all of the following components had to be considered: the voltage as determined by point-gap or sphere-gap, the reading of the milliamperemeter, the skin-target distance, and the thickness and material of the filter. This measurement is obviously inaccurate when dealing with electrical equipment subject to surges and fluctuations and easily affected by atmospheric conditions. The energy output of the tube is the only true standard. Two installations may be supplied with the same current and function with the same voltage as determined by sphere-gap; yet the output may vary according to the degree of pitting of the two targets, or due to differences in

the wave-form[2] produced by differences in rectification or in winding in the transformers. The same machine may show variations in output resulting from slight changes in the setting of the rectifying arms, although identical conditions of voltage and amperage are maintained.

American physicists and radiologists of the American Roentgen Ray Society were among the pioneers in devising instruments to measure the energy output of machines. In dealing with the heterogeneous bundle of rays emerging from the target it was found essential to study not only the quality or hardness of the rays but also the intensity or quantity. The quality is determined by the wave-length, or the absorption coefficient, obtained by spectrometry and instruments such as the Dessauer electroscope; the intensity is best ascertained by an ionization method, illustrated by use of the Friedrich iontoquantimeter.

In deep roentgen-ray treatment, after having determined the erythema dose by comparison with the output of a roentgen machine whose erythema dose is known or by standardization against radium,[3] depth dosage charts must be constructed, using an electroscope and measuring in a water phantom or through wax. These measurements may be confirmed by readings taken during treatments, inserting the ionization chamber into body cavities. We then know the percentage of the erythema dose reaching any desired point in the depth.

The surface intensity at any one portal is limited to the erythema dose. In order effectually to treat a deep-seated lesion several portals of entry may be chosen, and the beams of rays so directed as to intersect in the substance of the lesion itself, avoiding an excessive dose in normal tissue. There are several ingenious methods devised to accomplish this.[4] Often a depth dose amounting to five times the erythema dose is required in relatively insensitive tumors; here it is advisable to assist the surface radiation with radium in the interior whenever possible.

This is the status of roentgen-ray dosage today. The problem of the immediate future is to secure a reliable physical unit and a biological unit of measurement. We must look to the physicist to devise an electrical unit of ionization measurement capable of verification, so that under all conditions the same technique may be duplicated and biological results verified or discredited. Furthermore the very basis of our present standard—the erythema dose—is far from a precise entity and is no criterion by which depth intensities can be fairly judged.[5] There is no agreement on the degree of redness constituting an erythema.

When such an inflexible standard of dosage has been perfected, then we can begin to settle many obscure biological problems: the optimum dosage for various types of malignant growths, whether high or low voltage is preferable in the individual case, whether massive or fractional radiation yields better results, etc.

These present problems of deep roentgen ray therapy are not new; they are known and often discussed. It is hoped that reiteration will stimulate endeavor toward their solution.

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Vol. XVI, No. 4

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Publishers: PAUL B. HOEBER, INC., NEW YORK

Issued Monthly. Subscription $10.00 per year, $11.00 in Canada and $12.00 in foreign countries. Advertising rates submitted on application. Editorial office, 1909 Massachusetts Ave., N.W., Washington, D.C. Office of publication, 76 Fifth Avenue, New York.

Information of interest to all readers will be found on page vii. Lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on page preceding Editorial Section.

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EDITORIALS

THE ROENTGEN RAY AND RADIUM IN THE TREATMENT OF FIBROMYOMA OF THE UTERUS

THE roentgen ray and radium for the treatment of fibromyoma and the so-called metropathic hemorrhages have now been in use for a sufficient length of time and the technique has become sufficiently uniform to permit an evaluation of these methods.

Frances A. Ford[1] gives the following statistics and conclusions relative to fibromyoma based upon cases treated at the Mayo Clinic. The material studied consisted of 250 operated cases registered consecutively during 1918, and 344 cases treated by irradiation from 1914 to 1924. The average age of the patients treated surgically was 42.9 years; of the 245 patients treated by radium 44.4 years; of the 65 treated by radium and roentgen rays 46.3 years; and of the 34 treated by roentgen rays alone 47.1 years. While the presence of tumors had often been detected many years before the menopause, the symptoms, apparently had not been troublesome until the patient approached that period. Five of the patients treated by radiation were under thirty years of age and 3 of these had normal pregnancies following radium treatment.

An analysis of the pathological reports following operation showed 11 cases (out of 250) of unsuspected adenomyomas, 4 of carcinoma of the ovary and one of sarcoma of the uterus. There were 31 fibromyomas described as degenerating. About 40 per cent of the cases showed some chronic pelvic inflammation.

Ford states that since the 344 cases treated by radiation occurred over the period from 1914 to 1924 and were treated by a gradually changing technique, it is impossible to make a complete summary and comparison with the operated cases. It was found that a relatively high percentage of the irradiated cases required further treatment, either repeated irradiation (18 per cent) or operation (13.7 per cent), as compared with 4 per cent of the surgical group who received further treatment. Ford states in reference to this that the study of individual cases treated by irradiation shows so many satisfactory results that the discrepancy in the total results must be attributed to injudicious selection of cases or to inadequate dosage.

All writers on this subject emphasize the importance of correct diagnosis before any method of treatment is begun. It is necessary to determine that the growth is actually a myoma and not an ovarian cyst, ovarian carcinoma, or other tumor or disease of the adnexa. It is of especial importance to exclude carcinoma of the fundus uteri. The nature of the hemorrhage is usually suggestive but it is the opinion of those who have had the most experience that curettage should precede treatment in practically every case. The question of sarcomatous degeneration in a fibroid is relatively unimportant from the standpoint of deciding between surgical treatment and irradiation. The statistics show that sarcomatous degeneration occurs in a very small percentage of cases, quite certainly in a percentage not greater than the surgical mortality for operation on fibromyoma.

The question of accurate diagnosis before radiation treatment is instituted is of such importance that a caution to radiologists is not out of place. Unless the radiologist is also a gynecologist he should secure the advice and cooperation of a gynecologist in order to arrive at a definite idea of the exact condition.

Much has been written with regard to the presence of pelvic inflammation as a contraindication to roentgen and radium treatment of fibromyoma and uterine hemorrhage. Ford's statistics from the

[1] Ford, Frances A. A comparative study of radiation and surgical treatment for fibromyomata of the uterus. *Surg., Gynec. & Obst.*, February, 1926, xlii, 245–254.

Mayo Clinic, quoted above, show that about 40 per cent of the cases of fibromyoma which were operated upon showed some degree of chronic pelvic inflammation. This indicates that a considerable number of cases treated by irradiation must have this complication. Ford remarks, however, that the results of irradiation in the cases described revealed no evidence of exacerbation of an inflammatory process.

Although Miller[1] warns against the use of irradiation when there is a complicating pelvic inflammation, Pankow,[2] on the other hand, states that complications with inflammatory disease of the genital adnexa producing adhesions with neighboring organs may make the operative treatment very difficult; these are the cases, he states, which contribute most to the operative mortality of myomas, and are better suited to radiation therapy. It seems to be the rather general opinion that the presence of chronic pelvic inflammation is not in itself a contraindication to irradiation. It has been noted, however, that the manipulations necessary for the emplacement of radium may produce sufficient irritation to light up latent infections. This objection would not, of course, apply to the use of the roentgen ray.

The proper selection of cases for the various types of treatment is of prime importance. Miller and many other writers emphasize the fact that the mere presence of a fibroid is not an indication for treatment. In many women they are entirely symptomless and require no treatment whatever. If there is extensive calcification in the tumor little or nothing can be hoped for from irradiation.

The size of the growth is not in itself an indication of the type of treatment to be employed. Miller in the above quoted paper states that "only in exceptional cases should irradiation be done in growths larger than a three or three and a half months pregnant uterus." Schreiner in discussing Miller's paper stated that he did not believe "that the size of a fibroid is a criterion as to whether treatment should consist of surgery or irradiation." It is quite generally held that radiation treatment is applicable even to very large fibroids unless there are urgent pressure symptoms that necessitate prompt relief.

Much more important than the size of the tumor is the age of the patient. Patients must be classified into those in the childbearing period and those beyond it. Unless there are distinct contraindications to operation, it is generally held that surgical treatment is preferable in patients who may still expect to bear children. Miller estimates that myomectomy is feasible in about 12 per cent of the fibroid cases. When this can be done in young women without too much destruction of the uterine wall and when there is no disease of the adnexa, it is the treatment of choice. It has to commend it the fact that the ovarian function as well as the uterus is preserved. When the tubes and ovaries are not diseased in women who have not reached the menopause some advocate hysterectomy with preservation of the ovaries in order to avoid the artificial menopause which is brought on by irradiation. Irradiation, however, does not always produce permanent cessation of menstruation. Reports from numerous observers show that careful attention to dosage may bring about only a temporary cessation of menstruation in young women. Ford, in the article previously quoted, cites 5 patients under thirty years of age in whom radium was used, 3 of whom had normal pregnancies following radium treatment.

Observers vary widely in their estimate of the percentage of cases which are suitable to treatment by radium or the roentgen ray; Miller puts it as low as 30 per cent, but Ward in discussing Miller's paper estimates it as high as 70 or 90 per cent. The general opinion seems to be that at least two-thirds of uterine fibroids are amenable to roentgen or radium therapy.

Whether the roentgen ray or radium is the method of choice depends largely upon individual preference. In general, it may be said that the roentgen ray is much easier of application and causes the patient less inconvenience, but a more prompt cessation of bleeding can usually be obtained by the use of radium.

[1] Miller, C. Jeff. Radium in the treatment of fibroids of the uterus, its indications and limitations. Am. J. Roentgenol. & Rad. Therapy, September, 1926, xvi, 228–234.

[2] Pankow, O. Irradiation of myomas and hemorrhagic metropathies. *Strahlentherapie*, 1926, xxi, 222–241.

With regard to dosage, the rule is the same as in all conditions treated by irradiation, that is, it should be the minimum dose necessary to produce the required result; in this case cessation of menstruation. The usual procedure with radium is to insert a heavily screened capsule well up into the fundus and to leave it for sufficient time to give 1200 to 1300 mg-hr. Some advocate as high as 2400 mg-hr. but the smaller dose is probably sufficient in the majority of cases.

The writer uses the following technique for rotengen therapy: The skin between the umbilicus and the pubes is divided into four areas and in addition to these one area over the sacrum is treated. Over each of these areas the following dose is given: 5 ma., at an 8½ to 9 inch gap, for 5 min., through 5 mm. Al at 9 in. focus skin distance. This dosage is repeated after three weeks and again after six weeks. Three treatments are usually sufficient, but occasionally it is necessary to give a fourth; this is very rare, however. Some prefer to give the entire dose in one treatment by the so-called deep therapy method when the following dosage may be used: Over each of two areas, one in front and one behind, 500 milliampere-minutes is administered through 0.5 mm. Cu, at a distance of 50 cm.

The general opinion seems to be that irradiation either by means of radium or the roentgen ray is a proper and effective treatment in about two-thirds of all cases of uterine fibromyomata; that great care must be exercised in treating women in the childbearing period; and that large size of the tumor or the presence of chronic pelvic inflammation are not in themselves contraindications to this method of treatment.

Subscribers to The American Journal of Roentgenology and Radium Therapy *visiting New York City, are invited to make the office of* The Journal *(76 Fifth Avenue, New York) their headquarters. Mail, packages or bundles may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. Charles L. Martin, Dallas, Texas.
Twenty-eighth annual meeting, Montreal, Can., Sept. 20–23, 1927.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. Fred M. Hodges, 801 West Grace St., Richmond, Va.
Annual meeting, Washington, D. C., May 16–20, 1927.

THE RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Robert J. May, St. Luke's Hospital, Cleveland, Ohio.
Annual meeting, Milwaukee, Wis., Nov. 29–Dec. 3, 1926.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Sherwood Moore, St. Louis, Mo.
Annual meeting, Atlanta, Georgia, Nov. 15–18, 1926.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

THE CANADIAN RADIOLOGICAL SOCIETY
Secretary, Dr. E. C. Brooks, Montreal.

CENTRAL ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y. Three meetings a year—April, August and November.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. A. Arens, Michael Reese Hospital
Meets monthly on second Friday from October to May (except during month of December) at Virginia Hotel. Dinner at 6 P.M., scientific session at 8 P.M.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. E. P. McNamee.
Meetings are held at 6 o'clock at the University Club, on the fourth Monday evening of each month from September to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. Henry L. Ulbrich, 1130 E. Grand Blvd.
Meets monthly on second Friday from October to May, at Wayne County Medical Society Building.

THE NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. M. C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Eugene V. Powell, 217 East 42d St.
Meets monthly on second Monday, New York Academy of Medicine.

PACIFIC COAST ROENTGEN RAY SOCIETY
Secretary, Dr. Harold B. Thompson, Seattle, Wash.
Two meetings a year.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Eugene Pendergrass, University of Pennsylvania, Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. S. C. Davidson, Highland Hospital.
Meets monthly on the first Friday evening at 7.45 at the Rochester Medical Association Building.

ROENTGEN RAY SOCIETY OF CENTRAL PENNSYLVANIA
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.

ST. LOUIS ROENTGEN CLUB
Secretary-Treasurer, Dr. L. R. Sante, Metropolitan Building.
Meets first week of each month. Time and place of meetings designated by president.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. Davis Spangler, Dallas, Texas.

RADIOLOGICAL SECTION, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. C. A. Anderson, The Hospital, Dunedin.
Meets at Dunedin, New Zealand, during February, 1927.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

FIFTH RUSSIAN ROENTGENOLOGICAL AND RADIOLOGICAL CONGRESS
To be held at Kiev in May, 1927

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

BRITISH INSTITUTE OF RADIOLOGY
Secretary, Dr. John Muir, 32 Welbeck St., London, W. 1.
Meets at 32 Welbeck St., but regular dates and times of meeting have not yet been arranged.

THE BRITISH RÖNTGEN SOCIETY
Meets on the first Tuesday of each month from November to June inclusive, at 8.15 P.M., at the British Institute of Radiology, 32 Welbeck St., London; W. 1.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch.
Meets annually.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prag, II/52.

* Secretaries of societies not here listed are requested to send the necessary information to the editor.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY

Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA

Secretary, Professor M. Ponzio, University of Torino, Torino.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month during the winter at 8.30 P.M. at the Royal Society of Medcine, 1 Wimpole St., London, W. 1.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Meets in Copenhagen.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY

Secretary, Professor Holzknecht, Vienna, IX, General Hospital.

Meets on the first Tuesday of each month from October to July.

THE FOURTH RUSSIAN ROENTGENOLOGICAL AND RADIOLOGICAL CONGRESS, HELD IN LENINGRAD MAY 21–25, 1926

Over 350 roentgenologists and radiologists were present at the Fourth U. S. S. R. Congress held in Leningrad. Because of the great number of papers to be read some of them had to be shortened and the Congress prolonged for an extra day; the total number of papers read was eighty-two. Leningrad, Kiev, Moscow and Harkov were the best represented. Several foreign guests were also present at the Congress—Professor H. Holthusen of Hamburg, and others. Most of the papers were dedicated to the problem of the biological effect of radioactive energy and a great deal of attention was also given to roentgen diagnosis and therapy.

Reprev (Harkov) in his paper "The Synthesis and Analysis of Life Processes under the Effect of Roentgen Rays" acquainted us with the results of his experiments with regard to irradiating the eggs of a fowl previous to incubation. A single irradiation has a depressing effect on the synthesis of life processes and perverts their analysis. The chicken hatches later than is normal, is not sufficiently developed, does not possess any vitality, its physico-chemical constitution contains nitrogen in a quantity which is below the average, contains mineral parts and is somewhat richer in H_2O than is normal.

Krontovsky (Kiev) in his paper "On the Effect of Roentgen Rays on the Spleen Tissue and the Realization of the Effect *in vivo* and *in vitro* in various Conditions" has shown that the effects of roentgen rays on the elements of the cells depend not only on the dose received by the cells, but to a great extent also on the conditions in which the irradiated cells will exist in future.

Yugenburg (Leningrad) read a paper on "The Effect of Roentgen Rays on Nitrogen and Chlorine Metabolism." The investigations were carried out on 56 guinea pigs, which were subjected to both small and large doses of radiation. It was observed that guinea pigs subjected to a radiation dose of ½ skin unit dose showed a pronounced decrease in the amount of nitrogen discharged, owing to which fact nitrogen was retained in the organism; in those subjected to a radiation dose of $\frac{1}{10}$ skin unit dose, on the contrary, the quantity of nitrogen discharged increased. Inverted changes were observed in the process of nitrogenous metabolism as a result of the effect of roentgen rays. The changes in quantity of nitrogen contained in the blood have shown that the retention of nitrogen chiefly takes place in the liver.

Reprev (Harkov) in an exhaustive paper presented a detailed analysis of the quantitative and qualitative changes in the corpuscular elements in the blood of rabbits, which appear after irradiation with various doses of roentgen rays. He has also studied the changes in the fermentative consistency of the blood, in its viscosity and the effects of rays on the metabolic processes and gas metabolism.

Kotchneva (Leningrad) injected a solu-

tion of radon (emanation of radium) into the blood and the gastric cavity of rabbits and examined the changes in the contents of sugar in the blood. In half an hour after an injection of the solution into the ear vein hypoglycemia could be observed, whereas after an injection of radon into the gastric cavity hyperglycemia was observed.

Brullova and *Neelova* (Leningrad) studied the changes produced in the blood of guinea pigs by means of subjecting their spleens to irradiation with various doses of rays as well as by splenectomy. These changes are expressed by moderately varying absolute figures showing leucocytosis and by a double crossing of the curves showing lymphocytosis and neutrophilia, which are similar after irradiation by roentgen rays and after splenectomy. In every separate case the degree of this reaction depends to a much greater extent on the individual peculiarities of the animal than on the amount of the given dose.

Brullova (Leningrad) studied the effect of irradiation with roentgen and radium rays on saponine hemolysis.

Yasvoin (Leningrad) points out that in affecting a cell the roentgen rays in the first place destroy chondrosomes, this is followed by plasmopicnosis, which is further followed by changes produced in the nucleus of the cell. Golgi's apparatus is the most resistant element of the cell and its destruction characterizes the death of the cell.

Nadson and *Gleichgewicht-Rocblina* (Leningrad), having studied the effect of roentgen rays on the cells of an onion cuticle, have shown that the chondrium is the most sensitive amongst morphological components of the protoplasm. Not only do chondrosomes of two neighboring cells react differently to the effect of roentgen rays but even the chondrosomes of one and the same cell. The degeneration of chondrosomes manifests itself in swelling, vacuolization, dispersion to granules, lipophanerosis and in their losing the capacity of taking up mitochondrial dyes.

Voskresensky (Kiev) having irradiated a fly (*Drosophila*) comes to the conclusion that roentgen rays according to the condition of the cell, either produce on it an exciting or depressing effect, accelerating the life processes.

Philippov (Leningrad) has established by means of subjecting to irradiation various lower fungaceous organisms that roentgen rays, when applied in definite doses are able to produce constant changes, which become hereditary. These changes do not, however, appear in all organisms, which is due to the sensibility proper to their kind and species. By applying roentgen rays in fungi, *Nadsonia fulvescus*, Philippov discovered changes in the development of vegetative forms and chiefly in the sexual process. Sporogenous species lose their capacity of forming spores. Part of these changes are inherited by a series of generations (31 generations).

Lazarev and *Lazareva* (Kiev) inform us in their paper "The Functional Changes Produced in Blood Vessels by the Effect of Roentgen Rays" about their experiments carried out on the ears of rabbits isolated by Kravkov's method after they had been subjected to the effect of roentgen rays. According to the length of period elapsed after irradiation and the dose received the degree of excitation of the vaso-dilating and vaso-contracting apparatus either decreases or increases. These changes do not appear to be specific, as they are also observed during inflammatory processes.

Lazarev and *Lazareva* (Kiev) examined the skin of human beings subjected to irradiation with roentgen rays by means of a dermatoscope and pharmacodynamical methods. The functional changes in the reaction of blood vessels may be found even at a dose of ½ skin unit when there is still no distinct reaction which can be clinically defined.

Magat (Kiev) studied a series of physicochemical qualities which appeared in carcinomatous and embryonal tissue under the effect of calcium and acid solutions after they had been subjected to irradiation with roentgen rays.

Holthusen (Hamburg) read a paper "The Theoretical Grounds and Practical Application of the R-units dosimetry in Germany." The author, on principle, prefers the ionization method of measurement to any other. An equal number of dosimetrical roentgen units produce at an intensity of

over 100 kilovolts an equal biological effect independent of the length of the wave and this fact has been proved by the author's experiments on the eggs of ascarides.

Franke (Hamburg) demonstrated a new measuring device constructed by Küstner in accordance with the idea suggested by Holthusen.

The measuring is carried out independently of the temperature, the air pressure and changes of the electroscope, as each measurement is started by a comparison with the constant radiation of radium.

Voskresensky (Kiev) in the paper "The Problem of the Biological Dose" attempts to establish by means of a graphical method the connecton between the dose of roentgen rays, the age of the growing organism and the effect produced by radiation.

Sternman (Harkov) in his paper "The Constitutional Study and Roentgenology" points out the great importance of a constitutional approach to the roentgenological examination of both the healthy and the diseased human being. Practically it is the most convenient to divide the constitutional types into two classes: the narrow and the broad. The author also includes here a third—the round type. The author believes that a constitutional approach to the data obtained by roentgenological examinations will help to explain certain diseases which are of great interest to the roentgenologist (for instance osteochondropathia).

Maguid (Kiev) who examined roentgenologically four pairs of single fertilized egg twins and the same number of double fertilized egg twins states that in single fertilized egg twins a likeness of certain inner organs (the heart, stomach, intestines) does not always correspond to a great likeness in the outward features. The sella turcica in twins roentgenologically presents a great likeness.

The paper concerning the roentgen diagnosis of diseases of the gall-bladder according to Graham's method was read by Frenkel (Moscow). The examination of the bile passages by means of injecting into the organism tetrabromphenolphthalein or tetraiodophenolphthalein, doubtless, is a great success in roentgen diagnosis.

Stern and *Rabinovitch* (Saratov) point out the necessity in such cases of subjecting the patients to roentgenoscopy in a standing posture (cholecystoscopy). The authors' material embraces 24 cases.

Lemberg (Harkov) gives a survey of 35 cases, examined according to Grahams' method—10 cases *per os*, 25 intravenously. The author also emphasizes the necessity and importance of examining the gall-bladder roentgenoscopically to show its relation to the bulbus duodeni and the remainder of the duodenum.

Dillon and *Rubinstein* (Moscow) consider Graham's method to be technically a simple one and think it possible to apply it to out-patients with the aid of comparatively simple devices. The injection of the dye, though it may cause a considerable reaction, is in no way dangerous to the patient.

Yanovsky (Leningrad) instead of using phthalein compounds applied sodium bromide introducing large quantities of the salt *per os*.

Mordvinkin (Leningrad) considers a combined examination by means of contrasting salts and probing of the duodenum according to Meltzer-Lion's method to be a valuable diagnostical method for diagnosing cholecystitis.

Nemenov and *Ossinskaya* (Leningrad) presented a communication concerning 16 cases of myelography by means of lipiodol. This contrasting substance when introduced by means of a suboccipital injection into the subdural space of the vertebral canal enables the establishment of a topographically exact diagnosis in cases of growths of the spinal cord and meninges and in cases when the spinal cord is subjected to pressure by pathologically changed vertebrae.

Reinberg and *Arnstam* (Leningrad) presented a communication concerning their examination in 55 cases of the cavity of the uterus and tubes by means of lipiodol. These investigations made it possible to establish a series of physiological movements in both normal and pathological cases which as yet remained unknown.

Thus the existence of a sphincter apparatus at the uterine end of the tubes has been established, as well as the existence

of a peristaltic activity of the fallopian tubes; besides, the tone of the uterus has been studied, the mechanism of voiding its contents, etc.

The clinical value of metrosalpingography according to Arnstam's investigations is chiefly of importance for the diagnosis of the permeability and impermeability of the tubes in cases of sterility, in differential diagnosis of submucous and intramural tumors of the uterus and finally in early diagnosis of pregnancy. At the location of the ovum a spherical defect of filling may be roentgenologically defined in the uterus, the uterus loses its normal triangular shape and owing to atony of the muscles, becomes oval or annular. The authors have not observed any injurious effect produced by a careful injection of lipoidol on the further development of pregnancy.

Dillon and *Braude* (Moscow) applied 20 per cent iodipin for roentgenography of the female sexual organs and consider this method to be very simple and safe. The authors do not see any special advantages in a roentgenographical examination of the uterus as compared to the usual gynecological examination, whereas a contrast examination of the tubes has proved to be most important for defining the permeability of the tubes and for localizing the spot of obliteration.

Ginsburg and *Strokov* (Moscow) emphasize in their paper the value of the contrast method also in the differential diagnosis of myomas and cystomas. The application of various compounds of iodine may also have a therapeutic benefit.

Gotlieb and *Strokov* (Moscow) state the tremendous value of roentgenology in diagnosing diverticula of the bladder, when no sufficiently exact data are obtained by cystoscopy.

The roentgenoscopy of the bladder in various directions when it is filled with a 10 per cent solution of sodium bromide appears to be a most valuable method.

Samigin (Moscow) in his paper "The Roentgenological Nomenclature of Lung Tuberculosis" has presented a new scheme for the classification of tuberculosis which is based on immunobiological, clinical, pathologico-anatomical and roentgenological data.

Abramovitch, Varshavsky and *Sheinin* (Harkov) point out the value of roentgen rays in pneumoconiosis. The total number of cases examined was 700; among them 120 suffering from siderosis and chalicosis were examined as stationary patients. The authors divide cases of pneumoconiosis from the roentgenological and clinical point of view into two groups: the initial group, where there are but small deviations from the normal roentgenological aspect and pronounced forms with typical changes seen on the plates. Differential diagnosis between tuberculosis and coniosis of the lungs may be attended with great difficulties even with the aid of roentgenological examination.

Golst, Kaplunova and *Santotzky* (Moscow) in their paper "The Roentgenological Aspect of Pneumoconiosis in Workers of the Porcelain Trade" state that even in laborers who have worked in the porcelain trade for not less than fifteen years, any changes in the lungs are comparatively infrequent. At the same time in cases with inconsiderable clinical data, the roentgenological aspect in typical instances shows great changes.

Al and *Shik* (Harkov) give a survey of the differential roentgen diagnosis of various kinds of mediastino-interlobular pleurisies.

Liberman (Moscow) states on the ground of vast material that roentgen diagnosis of growths of the larynx is a very valuable method, of no less a value than the roentgenography of other organs. This method completes the laryngological examination in that the plate shows distinctly those parts of the larynx and trachea which remain inaccessible for a mirror examination.

Mordvinkin (Leningrad), who has examined 500 children under the age of fourteen years states that enlarged lymphatic mediastinal glands owing to pressure may change the configuration and size of the large blood vessels and the heart.

Simonson (Leningrad) gives a survey of 8 cases of an idiopathic dilatation of the esophagus or the so-called cardiospasm, describing in detail the roentgenological aspect of the disease, which has a decisive importance for establishing the diagnosis.

Den (Leningrad) describes in detail the differential diagnosis of mediastinal neoformations and discusses their treatment with roentgen rays.

Dillon (Moscow) in his paper concerning unilateral constant elevation of the diaphragm presents a detailed description of this not infrequent disease which is more generally known under the name of eventratio diaphragmatis; as a rule, a permanent elevation of the diaphragm may occur only on the left side of the body, whereas it occurs on the right side of the body only in those rare cases when the loops of the bowel are interposed between the liver and the diaphragm. The author points out a new symptom which enables the establishment by means of a roentgenological examination of the loss of tone of the diaphragm (the symptom of an expiratory increase of diaphragmatic motion)—the affected dome of the diaphragm starts rising after a deep inspiration previous to the beginning of an expiration and before the other dome.

Gusterin (Leningrad) presents a detailed survey of the differential diagnosis between hernia diaphragmatica and relaxatio (eventratio) diaphragmatis as well as of the methods of roentgenological examination and also describes 4 cases of a left diaphragmatic hernia. All the 4 cases were first diagnosed by means of a roentgenological examination.

Arkussky (Leningrad) devoted his studies to a clinical and roentgenological verification of the effect of the alkalis most frequently applied in the clinic on the secretory and motor function of the stomach. Not one of the alkalis possesses the quality, being applied in therapeutical doses, of absolutely lowering the acidity of the contents of the stomach; moreover, sod. bicarb. and calc. carbon in approximately 60 per cent increase the acidity after a test meal. Their favorable effect is chiefly based on their ability to accelerate the voiding of the stomach of its contents.

Bestchinskaya (Harkov) examined roentgenologically 30 patients who had been subjected to the surgical removal of the gall-bladder. The patients' complaints are usually caused by the presence of adhesions which may simulate both roentgenologically and clinically an ulcer of the duodenum. Only in one case of the 30 there were no postoperative adhesions around the organs surrounding the gall-bladder.

Sternman (Harkov) gives a survey of the examination of the liver and spleen in various oblique postures. He points out the simplicity and importance of this method of examination. The roentgenological aspect of these organs depends in the first place on their position; a change in their position may simulate an amplification or diminution in size.

Gambarov (Tiflis) considers the smooth muscles of the intestines to be an indicator of the tone of the vegetative nervous system. He roentgenologically examined the bowel in connection with the menstrual function. According to the data obtained by the author a condition of vagotonia may be observed during catamenia, whereas during the other periods a tendency towards an increased tone of the sympathetic nervous system is noted.

Rocblin (Leningrad) presented a systematic survey concerning the pathology of the ossification of extremities in endocrine diseases. The pathology amounts to a change in the rapidity of ossification (an acceleration or retardation) to a perversion in the order in which the points of ossification appear, to a disturbance in the harmony between the enchondral and periosteal ossification, and to a change in the site of ossification, that is, to the appearance of the so-called pseudoepiphyses.

Raitz (Moscow) presents a vast material concerning the diseases of the osseous system in early childhood, giving his attention chiefly to inherited syphilis. Owing to the fact that osseous changes are found in 80 per cent of the total number of cases of inherited syphilis and that these typical changes are the only symptoms of the disease with a total absence of any other phenomena, a roentgen examination is as important as the examination of the blood and spinal fluid when a case of inherited syphilis is suspected.

Dillon (Moscow) in his paper "Roentgen Diagnosis of the Diseases of the Temporal Bone" states that an examination of the temporal bone in various directions may give a very exact idea of the

condition of the separate sections of the inner ear. Roentgen diagnosis is of importance in differentiating between an acute and chronic mastoiditis.

Gasul (Leningrad) treates the problem of roentgenotherapeutics of lung tuberculosis in the light of the latest experimental and clinical data. By applying roentgenization one succeeds in accelerating the process of healing even in out-patient practice. Roentgen rays are but a subsidiary and nonspecific measure, which must be applied together with other kinds of radioactive energy, climatic and diatetic treatment, etc. In collaboration with *Zandberg* the author believes roentgen therapy to be indicated in slowly progressing cases of nodose and cirrhotic productive tuberculosis. Small repeated doses were applied (6–10 irradiations) during three to four months (from 5 to 10 per cent skin unit dose).

Rosenzweig (Harkov) recommends roentgen therapy in cases of compensated and sub-compensated broncho-adenites in children. When a careful technique of radiation is applied and that on specially selected cases, this method of treatment produces very satisfactory results.

Talrose and *Troosbin* (Tula) speak of the favorable results produced by roentgen treatment of tuberculosis of the larynx. Out of 9 cases the authors succeeded in producing a complete recovery in one case, an improvement in 6, and in 2 cases the condition of the patients showed no change.

Krouglikova (Kiev) used roentgen therapy on 70 patients of the Kiev Roentgenological Institute suffering from rhinoscleroma. The author believes roentgen treatment to be an effective measure against scleroma particularly if applied in combination with a previous cauterization with frozen CO_2.

Nemenov and *Grossman* (Leningrad) presented a communication concerning the primary results of treating surgical cancer by means of radon. The most favorable results are obtained in cases of cancer of the skin, the tongue, the mouth cavity and the lips. Out of the 60 cases which in the great majority of instances were entirely hopeless and which were previously subjected to various methods of treatment (roentgen and radium therapy included) but without any result, an application of radon produced a clinical recovery in 13 patients and an improvement in 26.

Archangelsky (Moscow) in his extensive paper "The Roentgenotherapeutics of Inflammatory Diseases in Gynecology" speaks of the very satisfactory and sometimes even brilliant results attained by roentgen treatment of chiefly para- and perimetritis of a post-partum origin. Gonorrheal conditions are less susceptible to roentgenotherapy, but very satisfactory results are obtained in tuberculosis in 60 per cent of cases. However, the author does not consider it possible to advise extensive application of roentgen therapy before it is proved that the rays do not produce any harmful effect on posterity. He states on the ground of observations carried out over an extensive period of time that 40 per cent of women subjected to radiation by roentgen rays are sterile.

Ribak (Leningrad) after applying roentgen therapy in cases of acute and subacute inflammatory surgical diseases (furunculosis, abscesses of the sudoriferous glands, paronychia, mastitis) comes to the conclusion that this method of treatment, sometimes together with a slight surgical interference is extremely valuable. The effect of roentgen rays manifests itself either in an interruption of the process or a rapid formation of the abscess which results in a spontaneous perforation or needs a slight incision which is followed by rapid healing.

The same favorable effect is stated in the paper read by *Vessely* (Kiev) who attained very satisfactory results in 82 per cent of the 300 cases treated according to Heidenhain's method.

Lazarev (Kiev) in his paper "On the Effect of Preliminary Roentgenization on the Development of Inflammatory Processes" showed that an inflammatory process, artificially produced in a rabbit's ear, developed during the first days which followed irradiation more intensively than on the ear that was not subjected to irradiation. Even doses which produce no clinically definable effect, affect the development of an inflammatory process.

Abramovitch (Harkov) speaks of the

favorable results attained by roentgen therapy of bronchial asthma.

Geinisman and *Cherni* (Kiev) attained very good results by applying roentgen therapy in 15 cases of growths of the epiphysis cerebri. The best results were obtained in cases of acromegalia and less favorable results in treating ophthalmic and adiposo-genital forms of the affections of the hypophysis.

The same authors made a contribution with regard to the highly satisfactory and at times even brilliant results obtained by roentgenotherapy in cases of syringomyelia Out of the 13 cases suffering from a severe progressive form of the disease roentgen therapy produced no improvement in the patient's condition in only one instance. Certainly there is no possibility of attaining a complete recovery from the disease even by applying roentgen treatment, although improvement usually occurs.

Jirmunskaya, Rocblin and *Kotcbneva* (Leningrad) consider psoriasis to be a pluriglandular disease with an always present influence of the hypophysis. In cases where the disease is chiefly due to changes produced in the hypophysis, irradiation of the hypophysis in conditions applied in deep roentgen therapy produces a very satisfactory therapeutic effect on the course of the disease.

Berenstein (Kiev) summarizes the results of treatment for fungaceous diseases of the head with radiation applied simultaneously on four areas ("quadriplex" method). In the total number of 1940 cases complete roentgen epilation was observed in 95 per cent of cases. This method, according to the author's viewpoint, being a method of mass epilation gives a considerably increased capacity to the roentgen room which is most important in conditions of country practice.

The same author suggests the application of chloral hydrate anesthesia for roentgenizing small children who do not lie calmly during the manipulation. According to the author's experience (268 children) this anesthesia, if applied properly, proves to be completely harmless.

Podliasbuk (Moscow) after subjecting the hypophysis of rabbits and puppies to roentgenization carried out a histological examination of their sexual glands. According to the author the reciprocal relationship between the hypophysis and the genitals is not yet as definite as it is considered to be by many other authors and the so-called "hypophysial castration" is not yet sufficiently grounded from the scientific point of view.

Porkbovnik (Kiev) in his paper "The Treatment of the Functional Lesions of the Ovaries during Climacteric" speaks of his experience obtained in 16 cases when he subjected to irradiation with roentgen rays the thyroid gland and the hypophysis. The treatment was applied to patients suffering from severe lesions and had a favorable result though no other methods of treatment produced any effect whatever.

Kaplan (Moscow) on the ground of his observations on 17 cases suffering from the same phenomena comes to the conclusion that irradiation of the hypophysial region produces very satisfactory results. The author did not observe any undesirable accompanying phenomena caused by the application of roentgen rays.

Stern (Leningrad) points out the favorable effect of roentgen therapy on nephrosis and nephritis.

Merkulov and *Sbick* (Harkov) consider that roentgen therapy ought to be ranked highest among all the local measures applied for the purpose of resorption of infiltrations in cases of parenchymatous keratitis. This treatment should be applied to cases which have suffered from the disease for longer than six months.

Protas (Leningrad) having based her observations on the material of the State Roentgenological and Radiological Institute comes to the conclusion that the method of increasing the sensitivity of tissues with regard to roentgen irradiation by means of an intravenous injection of a glucose solution (method suggested by Holzknecht's school in Vienna) does not produce any noticeable effect.

The representative of the State Department of Public Health in his paper "Organizational Problems of Roentgen Work" gives a detailed survey of the practical measures which the center is now introducing in order to raise roentgen work in the Union to a higher pitch.

The statistical data concerning the conditions of roentgen work in our country were presented by *Mankov* (State Department of Public Health).

Wainsbenker (Jitomir) acquaints the Congress with a series of complicated and very perfect devices and plants which the author has constructed or modified thus showing how the province, lacking the possibility of receiving necessary apparatus from abroad is still capable of adapting itself to modern needs and conditions.

Reinberg and *Kupritz* (Leningrad) studied the effect of roentgen rays on laborers employed in manufacturing roentgen tubes. By means of photographic measurements they calculated that the dose to which the bodies of certain workers of the trade are subjected 60 times exceeds the maximum dose which can be endured by a human being without producing a harmful effect on his health, and 30 times exceeds the dose to which roentgenologists are subjected.

Lazarev (Kiev) examined the peripheral blood vessels of 45 persons constantly subjected to the effect of roentgen rays. Pronounced changes were found only in those roentgenologists who had suffered in in the past from acute roentgen dermatitis.

Den (Leningrad) emphasizes the fact that according to the new educational program for the medical faculty roentgenology is not going to be treated as an independent branch of science. Leaving aside its practical value, roentgenology plays an important educational part as in this branch of science physical laws are applied with particular distinction to anatomical, clinical and physiological data, thus developing in the student the critical mind of the scientist. The roentgen-ray teaching as applied to the medical science ought to become a compulsory independent educational subject.

On May 24 a joint meeting of the Roentgeno- and Radiological Congress and the Gynecological Congress was held at the University Hall with over 1200 members present. The subject discussed at the joint meeting was the treatment of cancer of the uterus. The program paper read by the representative of the Gynecological Congress *Grusdev* (Kazan) was "Concerning the Surgical Treatment of Cancer of the Uterus." The program paper on the part of the Roentgenological Congress was read by *Nemenov* (Leningrad). *Nemenov* presented a survey of the problem of treatment with radioactive energy and discussed the advantages and disadvantages of both the surgical method and the method of treatment with radioactive energy. Further he described the results of treatment with radioactive energy applied in 1030 cases of cancer of the sexual organs in women patients (in collaboration with *Arnstam* and *Novotelnova*) and demonstrated 40 patients cured by a combined treatment of roentgen rays and radium. Among these patients were several who had been under observation for over five years. The author comes to the conclusion that operable cases may be subjected to treatment with radiation with no less reason than to surgical treatment. Whereas all doubtful and non-operable cases ought certainly to be subjected to treatment with radiation, as relapse of the disease, after the operation has been performed, produces much more dangerous results when treated with radiation than cases which had not been treated surgically. According to the author's impression, treatment with radon produces still better results.

The next congress will be held in the beginning of May, 1927, in Kiev. The following program subjects have been suggested:—

1. The succession of changes produced in the elements of a cell by the effect of radioactive energy (*Nadson, Krontovsky*).
2. Classification and roentgen diagnosis of diseases of the joints (*Stern, Reinberg*).
3. Functional and anatomical changes in the gastrointestinal tract following surgical interference(*Lemberg*).
4. Roentgen therapy of diseases of the hemopoetic apparatus (*Nemenov*).

Recommended subjects:—

1. Temporary sterilization with roentgen rays (*Gambarov, Aisenstein*).
2. Roentgen diagnosis of diseases of the bowel (*Dillon*).

SECRETARIAL COMMITTEE OF THE UNION ASSOCIATION OF ROENTGENOLOGISTS AND RADIOLOGISTS.

DEPARTMENT OF TECHNIQUE

Department Editor: DAVID R. BOWEN, M.D., Pennsylvania Hospital, Philadelphia, Pa.

In this department will be published from time to time, as material is available, suggestions for improvement in technique.

RIGHT-OBLIQUE-PRONE POSTURE FOR STUDY OF THE ESOPHAGUS

BY WILLIS F. MANGES, M.D.

PHILADELPHIA, PENNSYLVANIA

USUALLY we study the esophagus in the erect posture with the patient drinking barium mixture from a glass, but, as a matter of fact, it can best be studied with the patient in the right-oblique-prone position and drinking through a fairly large rubber tube. In this way, the entire length of the esophagus can be kept distended as long as the patient drinks, and when drinking through a tube he takes in less air. This is true not only when the esophagus is normal but also when strictured. In children too young, or ill-determined to drink as bidden, it is best to place them on the back and by one means or another force them to swallow the mixture. The patient must cooperate in order to distend the normal esophagus, but in case of marked narrowing of the lumen even small quantities of barium mixture serve to show the nature of the narrowing and approximately the degree of dilatation of the proximal portion.

The right-oblique-prone posture may not represent a new thought in esophageal study, but we are prepared to recommend it, and especially for lesions involving the lower three-fourths of the esophagus. The erect posture is probably the best for the study of the upper fourth. In any esophageal study, one should observe the behavior of a single swallow of thin barium mixture, and preferably with the patient erect. By this means an idea is gained of the location of the lesion in a stricture case, as well as its caliber.

Having located the stricture, preparation is then made to carry out the roentgenographic technique in the oblique-prone posture. The patient is made to lie prone with the right arm extended alongside the body and with the left arm flexed at the elbow and drawn up so that the patient rests on the elbow when rotating the body toward the right. The patient is then asked to lie a little on the right side with the left knee flexed, care being taken to keep the spinal column as nearly straight as possible. It is our custom to roentgenoscope the patient in this posture and have him take one swallow of the barium mixture through a rubber tube, so as to determine the best degree of rotation or obliquity of posture. The degree of rotation varies according to the location of the lesion and the shape of the patient, especially of the spine.

With the posture determined, the barium mixture is made thinner or thicker, according to the size of the narrowed lumen. The patient is asked to drink through a rubber tube of half an inch lumen. He is permitted to drink as much as the esophagus will hold, or, if the mixture passes fairly readily past the stricture, he is permitted to drink at least half a pint of the barium mixture, and then, as he takes the last swallow, he is instructed to stop swallowing immediately and at the same time hold his breath. In the meantime, a loaded cassette is placed under the patient and a tube overhead is in position and ready for quick exposure. At the instant the patient stops swallowing and breathing, the exposure is made.

When the obstruction is rather marked, one observes the degree of dilatation of the proximal portion, and when the lesion is in the upper fourth, he must be prepared to make the exposure promptly since regurgitation is rather rapid and difficult for the patient to control. When the lesion is in the lower three-fourths, the oblique-prone or nearly lateral posture serves best.

The principal advantage of the right-oblique-prone posture is that the esophagus distal to the stricture or lesion is distended with barium mixture, as well as the proximal portion. With the patient in this position, the lower end of the esophagus is at a higher level than the upper end and the force of gravity aids very materially in keeping the distal portion of the esophagus distended.

ADJUSTABLE DIAPHRAGMS FOR TUBE STAND

BY ROBERT B. TAFT, M.D.

CHARLESTON, SOUTH CAROLINA

THESE easily constructed diaphragms have proved so valuable that their description should be of interest.

The average roentgenologist has in his store room a discarded roentgenoscopic table which, when torn up, will yield one or two of the shutters used to limit the size of the field. These, when bolted onto 3 or 4 inch pipe couplings and onto face plates that fit the tube stand, serve the purpose well.

Of course, definite directions are unsuited to different kinds of shutters but anyone with mechanical ingenuity will have no difficulty in following the suggestion.

These instruments were primarily designed for superficial and moderately deep therapy but the circular one has been useful in roentgenographic work also.

These will be appreciated by the roentgenologist as savers of time and trouble and by the patient in eliminating the need of placing lead rubber on the body especially when the areas treated are on the face.

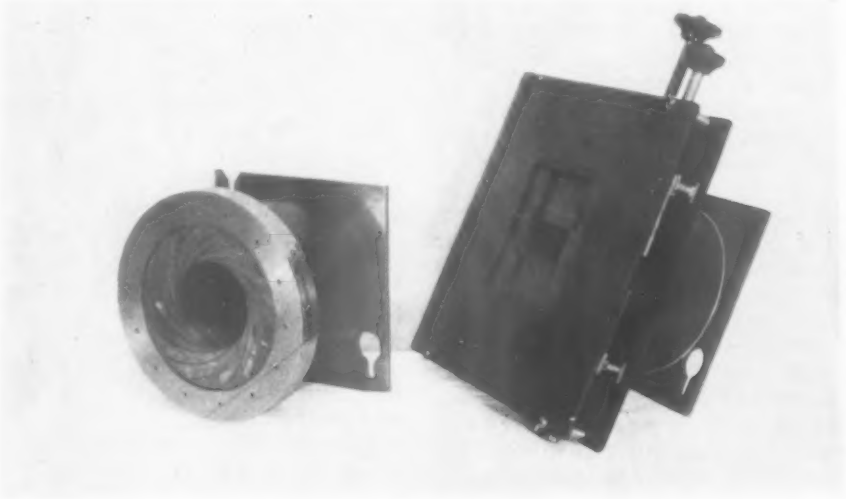

FIG. 1.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE X-RAY IN EMBRYOLOGY AND OBSTETRICS. By W. A. Newman Dorland, A.M., M.D., F.A.C.S., Professor of Gynecology and Obstetrics and Head of the Department of Obstetrics in the Post-graduate Medical School of Chicago; Author of "The American Illustrated Medical Dictionary;" and Maximilian John Hubeny, M.D., F.A.C.R., F.A.C.P. Editor of *Radiology;* Director of the Department of Radiology of the Physicians and Surgeons Institution; Cloth. Pp. 420, with 259 illustrations. Saint Paul, Minn.: Bruce Publishing Co., 1926.

It was with considerable pleasure that we perused this book. All too rare is the scientific work that is so well written as this one from the point of view of grammar and rhetoric. The huge number of facts presented do not readily lend themselves to orderly, coherent, rhetorical arrangement; its accomplishment, therefore, becomes noteworthy. Mention must be made here, also, of the editing of the book. It is distinctly well done, despite the fact that it was a task of more than usual difficulty.

Some exceptions, however, may justly be taken to the subject matter presented in the section of the book dealing with embryonic development. Chapter one, with its six pages of bibliography, consists of a masterly review of the literature on the effects of roentgen rays and allied agents on the tissues of the fetus and embryo. Chapter two takes up in detail the time of development of the centers of ossification in the embryo. A very valuable table showing the chronological order in which these centers appear in the embryo is included. But from this point to the end of the section on embryology—some 150 pages—very few facts relevant to the subject are presented. Most of the space is taken up with a discussion of methods of making roentgen examinations of the various systems of the body which have been adequately described in many other publications.

A few pages are devoted to the roentgenological estimation of the size of the fetal head and fetal maturity. Otherwise the text upon this matter is a frank digression from the subject. No new facts are offered, and most of those presented are familiar to roentgenologists; certainly the technique for taking a chest picture, or a kidney picture, in an adult is common knowledge, and the technique of ventriculography is obviously irrelevant in a discussion of the value or use of the roentgen ray in embryology. The same criticism may be made of the detailed discussion on the technique of roentgenographing and measuring the adult heart. If these subjects are pertinent to the subject of the book, the authors have failed to develop and make clear the connection.

In the section of the book devoted to a consideration of roentgenology in obstetrics, the authors adhere closely to the subject in hand. Their presentation of a large array of valuable facts of unquestionable authenticity should make this portion of the book immensely interesting to obstetricians. It is quite doubtful whether the majority of obstetricians realize the practical value of the roentgen ray in obstetrics, as outlined in this book. Briefly, this is as follows: (1) Examination of the normal and abnormal pelvis before, during and after pregnancy; (2) diagnosis of pregnancy; (3) diagnosis of abnormal pregnancies; (a) extrauterine; (b) multiple; (c) monsters; (4) differential diagnosis of pregnancy; (5) mechanism of labor, including expulsion of the placenta, and (6) medico-legal problems.

The first question the obstetrician asks as soon as the roentgen ray is mentioned, is, "What, if any, is the effect on the mother and fetus when the pregnant woman is x-rayed purely for *diagnostic reasons?*" Unless this question can be answered to his satisfaction the practical use of roentgen rays by the obstetrician is curtailed.

The authors present reliable evidence to prove that the roentgen ray does produce deleterious effects on the embryo, fetus and infant where the mother, while pregnant, has been exposed to the roentgen ray for *therapeutic purposes*. They do not produce evidence, however, to prove whether or not the fetus or mother is injured when the pregnant woman is subjected to the comparatively short exposures necessary for *diagnostic purposes*. Nowhere in the large mass of literature referred to, and freely quoted from, does there appear any indication of observations made on the infants born to mothers who, while pregnant, were exposed to diagnostic rays. Only statistics arrived at by such observations will furnish an answer to the obstetrician, who, in turn, must make satisfactory reply to the searching questions of his patients.

A review of this book would be incomplete without mention of the illustrations. They are of unusually good quality and number. The authors are to be congratulated on the accumulation in one book of such a large collection. This includes plates of injected specimens, demonstrating the cardio-vascular system in the fetus. Roentgenograms of injected placentae show very beautifully the arrangement of blood vessels. The collection of pictures of monsters, of deformed pelves, and of those showing the development of the centers of ossification, is a remarkably fine one. The plates, the bibliography, the references, and the text itself, indicate that an enormous amount of work must have been performed in the writing and editing of this book.

The volume, on the whole, is a distinct addition to roentgenologic literature and deserves a place in the libraries not only of roentgenologists but also in those of pediatricians and obstetricians and of everyone interested in embryonic development and anomalies.

H. S. Hoffman.

Electrothermic Methods (Desiccation and Coagulation) in the Treatment of Neoplastic Diseases. By J. Douglas Morgan, B.A., M.D. Cloth. Price, $2.50. Pp. 172, with 36 illustrations. Philadelphia: F. A. Davis Co., 1926.

The author makes no claim to originality in the subject matter and appends a full bibliography of sources. The clear definitions and correct terminology of surgical diathermy should bring order out of a field in which there is great confusion in the literature. The chapters on principles of electricity, and the clinical and physical effects of currents can be easily understood by one not versed in physics. The fundamental features which should be found in apparatus for diathermy are described and illustrated with practical exercises for its use.

The method of treatment of the more common neoplasms is briefly but adequately described, along with the method of anesthesia. A fair appraisal of the comparative value of electrodesiccation, electrocoagulation, radiation therapy and excision by the knife is given.

Surgery by the use of high frequency current is touched upon but the author feels that the period of its use is too short to judge the value of such means.

The book is especially valuable to the roentgenologist since endothermic methods combined with radiation therapy offer satisfactory treatment of many lesions for which neither alone proves adequate.

F. O. Coe.

BOOKS RECEIVED

The X-ray in Embryology and Obstetrics. By W. A. Newman Dorland, A.M., M.D., F.A.C.S., Professor of Gynecology and Obstetrics and Head of the Department of Obstetrics in the Post-graduate Medical School of Chicago; Author of "The American Illustrated Medical Dictionary," and Maximilian John Hubeny, M.D., F.A.C.R., F.A.C.P., Editor of *Radiology*, Director of the Department of Radiology of the Physicians and Surgeons Institution. Cloth. Pp. 420, with 259 illustrations. Saint Paul, Minn.: Bruce Publishing Co., 1926.

The Duodenal Tube and Its Possibilities. By Max Einhorn, M.D., Professor of Medicine at the New York Postgraduate Medical School; Visiting Physician to the Lenox Hill Hospital, New York. Second edition, revised. Cloth. Price, $3.00. Pp. 206, with 126 illustrations. Philadelphia: F. A. Davis Co., 1926.

Injuries of the Wrist. By Dr. Etienne Destot, Lyons. Translated by F. R. B. Atkinson, M.D., Edinburgh University. Cloth. Price, $6.00. Pp. 169, with 87 illustrations. New York: Paul B. Hoeber, Inc., 1926.

Physical Therapy in Diseases of the Eye, Ear, Nose and Throat. By Abraham R. Hollender, M.D., Attending Otolaryngologist, American Hospital of Chicago; Editor, *Archives of Physical Therapy, X-ray, Radium;* and Maurice H. Cottle, M.D., Attending Otolaryngologist, Illinois Masonic Hospital at Chicago. Cloth. Pp. 307, with 81 illustrations. New York: The Macmillan Co., 1926.

A Practice of Physiotherapy. By C. M. Sampson, M.D. Cloth. Price, $10.00. Pp. 620, with 146 illustrations. St. Louis: The C. V. Mosby Co., 1926.

Surgery of Neoplastic Diseases by Electrothermic Methods. By George A. Wyeth, M.D., New York. Cloth. Price, $7.50. Pp. 298, with 137 illustrations. New York: Paul B. Hoeber, Inc., 1926.

Electrothermic Methods (Desiccation and Coagulation) in the Treatment of Neoplastic Diseases. By J. Douglas Morgan, B.A., M.D. Cloth. Price, $2.50. Pp. 172, with 36 illustrations. Philadelphia: F. A. Davis Co., 1926.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

Ely, Leonard W. Sprengel's deformity *Arch. Surg.*, October, 1925, xi, 598–601.

A case is reported in a boy aged eleven. This child had been born with the left shoulder higher than the right and the deformity had steadily grown worse. There was curvature of the spine but no pain other than an occasional dull ache. Examination showed a very high left scapula very close to the spine, with a lateral curvature in the cervical region and an asymmetry of the face. The scapula evidently was attached at its superior angle, and at this point there was a distinct prominence, a bony growth which ran to the spine. The motions of the head were limited. The roentgenograms showed the high scapula and a bony growth like a short rib running from it to the spine at about the level of the sixth or seventh cervical. The cervical spine was curved and the lower cervical vertebrae showed various developmental abnormalities sufficient to account for the curvature, even in the absence of the scapular deformity. They were described as a failure of union of the arches of the last two cervical and the first thoracic vertebrae and a transverse division of the second cervical body.

An operation was performed and the growth was bared by subperiosteal dissection. It consisted of bone with cartilage at its scapular end. There was very little motion between it and the scapula, and no motion was demonstrated between this "rib" and the spine. The articulations with the cervical vertebrae were separated and the bone was removed. It appeared like a small thick rib.

The patient was seen sixteen months after the operation. At this time the deformity was somewhat better but still was quite severe. In a case like this with well marked spinal deformity any operation on the soft structures of the neck with the object of depressing the scapula would almost certainly be futile. The high shoulder is manifestly caused by the spinal curvature.

Ferber, Julius. Local atrophy as an anomaly of bone metabolism. *Arch. Surg.*, November, 1925, xi, 708–717.

Of special interest are the bone changes found in cases of so-called vasomotor and trophic neurosis. In Raynaud's disease, the roentgenogram shows bone atrophy and rarefaction of bone structure, narrowing of the cortex and even bone erosion. Bone changes also are found in cases of scleroderma of the fingers and toes. Bone atrophy as an independent pathologic condition is probably to be found most often in the lower extremities. This is due to the fact that venous congestion and circulatory disturbances are more easily brought about in the lower than in the upper extremities.

A case is reported in a man aged fifty-nine, subject to attacks of angina pectoris and suffering from diabetes mellitus, who complained of loss of weight, sensation of cold in the feet, tingling, numbness and severe pain of the big toe on the right. No pulsation was discernible in the tibialis posticus or dorsalis pedes in either foot. In the roentgenogram there was a very definite line of demarcation sharply defining the soft parts as they were affected by the blockage of the circulation. In this case, therefore, there was definite clinical evidence of arterial occlusion as the cause of the atrophy.

Three other cases are described which did not show any definite lesions preceding the bone atrophy, lesions which could be regarded as the cause of the symptoms complained of. There was no evidence of articular or periarticular inflammation, and the bone changes were due primarily to a disturbance of bone metabolism. The immediate cause of this anomaly is a disturbance of the very fine adjustment of bone nutrition. A constant and free blood stream, both in the arteries and the veins, is a prerequisite to a steady supply of substances necessary for bone anabolism, to the removal of waste products, to the maintenance of the proper hydrogen ion concentration of the circulating medium, and to the keeping up of that tension which regulates the migration of osteoclasts. This delicate mechanism is under the regulatory control of the nervous system. Disturbances of the harmonious cooperation can be brought about directly by pathologic irritation or by the failure of normal stimuli which regulate bone metabolism. The end result is always a disturbed blood supply to the bones. Direct blockage of the circulation, if gradual in its onset, also leads to atrophy.

Fischer, A. W. On the roentgen examination of the large intestine with the aid of a combination of air injection and contrast enema ("combined method"). *Arch. f. klin. Chir.*, 1925, cxxxiv, 209–269.

The methods available for the roentgenological study of pathology of the large intestine are: (1) study of the passage of a contrast meal;

(2) the characteristics of contrast enema, and (3) various procedures for inflating the large intestine with air. It must be admitted, however, that there are many cases in which a satisfactory diagnosis cannot be reached through the ordinary methods of the contrast meal and the contrast enema.

Among the disadvantages of the contrast meal may be mentioned; the large intestine can never be inspected in its entirety, many roentgenoscopings are necessary, the irregular distribution of the contrast material often gives rise to questionable filling defects, and on the other hand, incomplete stenosis and ulcerations often remain unobserved. The contrast enema yields better, more uniform filling of the intestine, but every roentgenologist knows how difficult it often is to display definitely the cecum or the ascending colon. The most important disadvantage of both methods lies in the fact that use is made of the ray-opaque contrast material. Loops that cross each other are consequently difficult to disentangle, tumors projecting into the intestine are often obliterated and become visible only under particularly favorable conditions, while ulcers cannot be demonstrated.

The use of air as a contrast material has the advantage that the large intestine is always definitely and completely inflated, especially the oral end, and in addition tumors projecting into the lumen of the intestine become visible. The practical utility of air filling is made uncertain by the very indefinite marking of the intestinal contours, and it is for this reason that the method has not been pursued in practice to any great extent.

The author suggests a combination of the methods of air injection and contrast filling which avoids the disadvantages of each. The intestine is partly filled with a barium mixture and is then inflated with air and shaken, so that when the mixture is drained there remains a distinct coating of contrast material on the mucosa, thus yielding sharp contour markings in the roentgen picture. In the examination of patients, the combined method is conducted as follows: The contrast enema is first given and its progress followed on the screen. The fluid is then either entirely, partly, or not at all removed, depending on the position in the individual case, and the customary air injection is made *per anum*. The unfoldings of the intestine by the air is again observed roentgenoscopically, either in the standing position or in lateral recumbency, with the roentgen beam horizontal. In order to secure good demonstration of the contours it is advisable immediately before examination to roll the patient around several times so as to bring the contrast material in contact with all parts of the intestinal mucosa.

In the examination, attention should be directed to the following points: The contour of the wall through its entire extent. Even when several loops are superposed the contours of the individual loops are distinct and can be differentiated, this revealing anomalies of position if present. The nature of the contour should be studied as regards its uniformity and the fineness of the linear markings. Irregularities, more or less gross spots indicate adherence of contrast particles in the roughness of an ulcer. Abnormal linear markings on the contour indicate adhesions and attachments through pericolitis. The streaks, ellipses, and circles observed in various angles are due to the contractions of the circular muscles. When these lines remain intact, pathological changes may be excluded in that area. The tracing out of these lines from one wall contour to another reveals the relationship of the corresponding walls.

The position of the level of contrast fluid yields information as to the course followed by the intestine and upon the conditions of internal pressure. Attention should be paid to the details revealed in the lumen; where the intestine runs parallel with the roentgen beam the shadow on the plate is more dense. Tumors, contrast particles adherent to rough or ulcerating mucosa, fecal balls, and foreign bodies are easily recognized. One should avoid confusing a bone shadow projecting into the field of the lumen with a tumor. The degree of unfolding of the large intestine is important as it gives an indication regarding pericolitic attachments. Further information regarding adhesions can be obtained by a study of the displacement produced by the air injection upon mobile portions of the intestine in various positions. The size of the spleen and the liver can be determined. The gall-bladder cannot always be visualized, but adhesions between the stomach and region of the gall-bladder can be shown because the normally motile stomach is pushed over to the left by the rising air-filled transverse colon which runs toward the left lung and liver.

The combined method above outlined is better than present procedures in various respects. It is especially advantageous as a procedure in the early diagnosis of cancer of the large intestine, and it may yield valuable information in those cases where indefinite colic symptoms arouse suspicion as to the presence of a carcinoma. It is also useful in the localization of indefinite abdominal tumors. For purposes of diagnosis and judgment of disturbances in intestinal function the method of study of the contrast meal remains the best procedure.

Eighteen cases are described and discussed in which the combined method of examination demonstrated its utility.

FRANK, J. A rare case of injury of the carpus; dorsal dislocation of the trapezoid bone. *Acta radiol.*, 1925, iv, 281–284.

A workman, twenty-five years old, while riding on a bicycle collided with a lamp-post on the right side of the road, thereby striking the handle bar violently against it. The right handle turned inward, the right pedal scraping the post. The bicycle slid down under the man who remained straddling it. He kept hold of the handle but felt pain and a slight loss of strength in his right hand. There was no external contusion but there was a hard tumor at the radial side of the carpus and beside this a cavity from which the bone had jumped. Attempt at replacement was not very successful.

The dorsovolar roentgenogram of the right hand shows the trapezoid out of place and completely covered by the trapezium. The os magnum and the metacarpals are in slight adduction. The cleft between the os magnum and unciform is too narrow, the cleft between the ulnar part of the base between the second metacarpal bone and the os magnum being too wide. The lateral roentgenogram shows the trapezoid protruding at the dorsal side. Evidently the bone had jumped out of the carpus and turned round afterwards so that the proximal concave side was turned to the radial side.

Massage and local exercises were instituted but the patient still shows the same hard tumor and a little swelling, with abduction of the hand almost impossible, and dorsal flexion very limited.

In gripping the handle bar of the bicycle, the hand is in adduction and ulnar flexion; and the thumb is in apposition and flexion, a position in which the dorsal ligament is quite tense. The position of the trapezoid has become freer, and is not checked at the back by any bone. An analysis by the principle of the parallelogram of forces show that the trapezoid is bound to be dislocated at the back under the circumstances as outlined.

FRAENKEL, EUGEN. Multiple enchondromas. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 775–779.

A case is reported in a woman aged thirty-two, who at the age of twelve on the occurrence of the first menstrual period noticed a soft nodule on the ring finger on the right hand. This grew larger and was removed three years later. Other nodules re-appeared over the hands. At the time of examination these nodules covered the hands and the upper third of the upper arms towards the axillae. Several of the nodules were present in the anterior chest wall. The rest of the body was free and the blood and urine were negative.

The clinical findings were inadequate but the roentgen picture clarified the diagnosis. In the hands there was an affection both of the osseous system and of the venous circulatory system; but examination in other parts of the body where these nodules were absent showed a considerable involvement of the skeleton alone. The deforming nodules in the hands were seen to be due to small bodies with a concentric structure, namely, phleboliths. These were entirely independent of the osseous changes throughout the skeleton. It cannot be stated definitely whether the nodules were simple varicose enlargements or pure cavernomas or collapse of the latter in the venous region of the arms and hands.

The skeleton showed typical multiple enchondromas. The zones involved were the hands and feet, especially in the metacarpals and metatarsals and the phalanges, with localization in the diaphyses adjacent to the epiphyses. These osseous changes developed centrally and none had progressed to the point of affecting the bone cortex.

A similar case was reported by von Recklinghausen in 1889. Although no roentgenographic data were then possible, nevertheless the anatomic description quite fits the present case including the association of the phlebolith formation and enchondromas. It is concluded that these venous structures as well as the enchondromas are probably due to a faulty primary anlage and that the venous tumors must be considered as congenital blood tumors.

A therapy of the condition seems impossible. Further observation of the case will determine if the condition tends to become stationary or progressively worse.

GEIGER, OTTO. Cholecystography. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 577–580.

A brief review is presented of the cholecystographic methods devised by Graham and his collaborators. The procedure will have to be still further improved in order to eliminate undesirable reactions. However, attention is directed to the fact that unwelcome reactions are also obtained in other diagnostic procedures. For instance, pyelography is certainly not a non-hazardous procedure for every patient. The same may be said for pneumoperitoneum, but it is certainly worth while to attempt the

diagnostic procedure before subjecting the patient to an operation that may perhaps be avoidable.

The advantages of cholecystography are enumerated as follows: It permits the demonstration of stenosis of the cystic duct; (2) gall-bladder inflammations without stone which often produce the pains of gallstone colic may be recognized by the pathological form of the gall-bladder, the lower intensity of the shadow and its firm fixation; (3) the finding of a normal gall-bladder will prove of distinct differential value in the diagnosis of symptoms of adhesion, pains of a pyloric or a duodenal ulcer, in appendicitis or pancreatitis; (4) the changes in position of the gall-bladder will be better understood; (5) differential diagnosis against kidney stone will be simplified; (6) in roentgenographing gallstones there is an advantage in that no special technique is required.

GOLDHAMER, KARL, AND SCHÜLLER, ARTHUR. The varieties of the sella turcica. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 894–900.

Apart from the innumerable variations in the size and shape of the sella turcica to be found in the different age groups, the well-known roentgenographic profile picture of the hypophyseal depression may be modified by multi-shaped projections. These projections or spicules are largely contained as bone structures in pre-formed dural columns of the sellar region. A peculiar form which has hitherto not been more closely studied is that designated as dorsum sellae elongatum. No convincing evidence has yet been offered in explanation of the pathologic cause for the above-mentioned bony projections; and all the factors support the assumption that these are normal structures. The assumption made by several authors that the bone spicules in the sellar region are the cause of injury to neighboring soft tissues has has not been conclusively demonstrated.

GRANGER, AMÉDÉE. Roentgenographic examination of the sphenoid sinuses. *Radiology*, January, 1926, vi, 23–33.

In order to obtain greater uniformity and better duplication of roentgenograms of the sphenoid there was devised a head rest or sinus mask, without which the alveola-glabella position of the head would be impossible. The cassette is covered with the sinus board or mask on a 17° angle block arranged so as to give a 107° inclination to the sagittal plane of the head. The nose must be inserted in the aperture in the sinus mask and the upper jaw (alveola) and a line uniting the eyebrows (glabella) must rest firmly on the board. The central ray is directed vertically through the head on a line just below the external auditory meatus. It is absolutely essential that the head rest and bear firmly and evenly on the alveola and the glabella, and that the angle block have an angle of exactly 170°. The shadow of the petrous bone is then found to be situated about the center of the orbit without extending beyond the upper or lower borders of the latter. Under these conditions the sphenoid region has the greatest area.

The above technique is more simple than that of Aspray in which the central ray is directed through the head in the postero-anterior direction at an average of 18°. Moreover, experience has shown that to detect pus in the sphenoid region it is necessary to incline the head and not the central ray. When there is pus in the sphenoid, the Granger line (upper boundary of sphenoids) becomes invisible.

It has been shown experimentally and clinically that pathology of the frontal sinuses has no effect on the visualization of the Granger line. This is of importance since in the Granger technique the sphenoid region is visualized through the frontal sinuses.

Prolonged observation has re-affirmed the views previously expressed that the Granger line is not only the most important landmark to be seen on roentgenograms of the sphenoid but that it has also a diagnostic value. In empyema, the pus gravitates down to the most dependent portion of the sphenoid wall and its shadow blending with that of the latter causes the Granger line to be invisible. In hyperplasia the broadened line, with indistinct lower edge, is caused by hyperplasia of the periosteal or perichondral membrane and the diminished density of the line is due to the resulting bone atrophy. In polypoids, the sphenoids and ethmoids become very opaque, because they are filled with polypoid tissue instead of air, and the opaque shadow thus formed blends with and obliterates the shadow of the Granger line. In osteoplasia the line is broadened without loss of density or sharpness of outline because of the osteoplastic changes.

Hyperplastic sphenoiditis, by far the most common pathology of the sphenoid observed by the author, and the most difficult to recognize by other methods, can be definitely and positively diagnosed by the Granger technique under routine conditions.

Brief reports are given of 4 cases which were examined roentgenographically in the Pfahler, Pirie or Hirtz, lateral and Granger positions. The latter yielded diagnoses that were confirmed otolaryngologically, while the other roentgenograms were inconclusive or misleading.

Haenisch, F. Unusual cases. (a) polypous gastric tumor; (b) arthropathia deformans of the costotransverse articulations; (c) arthritis deformans of the hip joint; (d) sagittal doubling of the patella. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 676–679.

(a) The polypous gastric tumor was found in a woman aged sixty-one, who had had gastric trouble for the fifteen years preceding. The roentgen examination with the aid of the contrast meal showed a smooth passage through the esophagus. The stomach was very slightly hypotonic, had a siphon shape with the caudal pole 2 to 3 fingers' width below the level of the crista. There was some raggedness at the larger curvature. The small curvature was sharp in outline and showed no indentations or niche shadows in the various oblique and frontal positions. As the stomach filled, a defect was observed in the antral portion originating in the small curvature and extending into the pre-pyloric antrum. By avoiding pressure on the abdominal wall the filling defect disappeared almost completely after the entrance of the whole test meal, but upon the slightest touch over the antrum it reappeared with typical symptoms. This filling defect was of the size of a walnut when first seen; and its anatomical substrate could be easily moved towards the cardia or the pylorus and appeared pedunculated. The peristalsis appeared to run normally along both curvatures. This relative filling defect was distinctly noticeable with the patient either in the prone or supine positions but it changed its location with respect to the stomach shadow as the patient was moved. At operation the polypous tumor was found in the smaller curvature immediately before the pylorus. It had a rather broad base and looked carcinomatous. Total resecton was performed but the patient died four days later of peritonitis and pericarditis. The histological examination of the tumor showed adenocarcinoma.

(b) Arthropathia deformans of the costotransverse articulations was observed in a workman twenty-two years old, who developed an acute pain in the back eighteen months previously while trying to raise a heavy bag. He suffered considerable pain between the shoulders from the level of the twelfth thoracic vertebra downward. Roentgenological examination from the frontal and sagittal positions showed nothing pathological in the vertebrae or in the spinal arches. The thoracic spine had a slight convex scoliosis to the right, and appeared more angular than bowshaped at the level of the sixth thoracic vertebra. The dorsoventral roentgenogram of the upper thoracic spine showed in the left third, fourth and fifth costotransverse articulations and in the right fifth costotransverse articulation strap shaped bone structures and marginal osteophyton-like bone proliferations which completely bridged a part of the distinctly recognizable joint space. The beak-shaped straps extended from the transverse process over to the costal tubercle. The remaining costotransverse junctions appeared free. This finding gave an adequate explanation of the patient's complaint.

(c) Arthritis dissecans of the hip joint was found in a man aged thirty, who had been complaining for three years of gradually increasing pain in the left hip, and had been under treatment for sciatica and similar conditions without relief. A previous roentgen examination had yielded nothing definite. The author made a roentgenographic study which was entirely negative in the usual ventrodorsal and sagittal projections. However a distinct bending of the neck of the femur was discovered when the patient was examined with the femur in extreme abduction and external rotation, the roentgenogram being taken in the caudocranial oblique projection. There was a typical arthritis dissecans of the head of the femur. At the head in the vicinity of the internal joint surface there was nested an isolated bone fragment about the size of a bean.

(d) Doubling of the patella of a type hitherto undescribed was found in a woman aged forty-eight, who twenty years previously had encountered acute pain in the left knee during calisthenic exercises. This pain had disappeared after a time, but when the patient undertook garden work which required kneeling a pain in the right knee appeared. The condition was previously treated as a chronic arthritis of the knee. Roentgenographic examination of the hip joints showed a decided arthropathia deformans (mallum coxae senile?) especially to the right. In the knees there was very slight evidence of deforming arthropathy but an unusual anomaly was discovered, viz., a bilateral doubling of the patella in the sagittal plane. Each knee had a practically normal sized patella in front of which there was a second somewhat larger but flatter disc, the structures being separated from each other by a joint space. In this case there was undoubtedly a congenital anomaly not in any way related to the arthritic symptoms.

Hamburger, L. P., and Nachlas, I. W. Leontiasis ossea as a manifestation of Paget's disease. *Arch. Surg.*, March, 1926, xii, 727–739.

Leontiasis ossea is still a useful term descriptive of hyperostosis of unknown origin and of

rare occurrence chiefly affecting the skull. Roentgenologic study of the skull and other bones and the results of clinical examination justify the inclusion of the example cited in the group of deforming osteitis called Paget's disease. The etiology of leontiasis ossea is unknown but the fact that in so many instances the disorder begins in or near the nasal or paranasal cavities lends support to the view that infection plays a rôle in its origin. It has been suggested that endocrine disturbances may be contributory.

The case described was observed in a woman aged fifty-six. The leontiasis was of twenty-eight years' duration, its onset occurring during pregnancy. The roentgenologic study of the skull and long bones showed changes characteristic of Paget's disease. The cephalic shadow showed round knob-like masses of bone lying between the inner and outer tables, some of the masses being on the outer table. Besides the changes in the cranial and facial bones the clavicles were thickened and tender, and also the upper thirds of the humeri. There was an increase in the anteroposterior curve of the spine and both tibias were bowed anteriorly. There was tenderness to the touch over the anterior surfaces of the tibias together with local elevation of temperature without redness. The upper third of the femur showed thickening of the cortex with irregular areas of porosis. A similar condition of porosity existed in the lower lumbar spine, in the top of the sacrum, in both innominate bones, especially the right, and in both ischia. The tibias were thickened and showed longitudinal striae of porosis.

HANSEN, SVEND. Röntgen diagnosis in osteitis fibrosa and tumours of the bone system. *Acta radiol.*, 1925, iv, 201–219.

There is a close relationship both clinical and morphological between osteitis fibrosa, osteitis deformans, epulis, and the myelogenous sarcomas, and there are frequent difficulties in the way of microscopic examination in such cases. Just as the histologist is often baffled, so is the roentgenologist in an attempt to diagnose these affections of the bone system. The diagnosis must in many cases remain uncertain, requiring the employment of other methods of examination, even probatory excision, before a more extensive operation is decided upon.

The first case reported was in a woman aged sixty, under observation for the preceding eleven years, who presented an exceptionally typical case of generalized osteitis fibrosa with excessive cyst formation almost all over the skeleton. This condition could be readily differentiated from multiple cancer metastases because in osteitis fibrosa the clear spaces are very large and confluent without osteosclerotic areas present. The pelvis is comparatively little affected in this disease. In cancer metastases, numerous small clear spaces are seen either sharply defined, or woolly. In multiple myeloma there are likewise found less sharply delimited clear spaces, but taken all in all, it is not believed possible to set up differential diagnostic criteria between this case of multiple bone cysts and multiple bone tumors of sarcomatous, carcinomatous, or myelomatous nature.

Two other cases are described which very closely resembled localized osteitis fibrosa but the diagnosis was by no means certain. The scraped out tumor of the bone cyst in one of the cases showed some giant cells contained in a non-osseous tissue consisting of closely placed fusiform cells arranged in bundles. The histological diagnosis was sarcoma. In the other case, the histological examination of the well-delimited tumor in the femur was negative.

Brief descriptions are given of 4 cases of cancer metastases in women suffering from mammary carcinoma, and one case of multiple myeloma.

HAUDEK, M. The reliability of stomach niche in ulcer diagnosis. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 651–661.

Gastric niche is regarded as entirely reliable as a pathognomonic symptom when it occurs in conjunction with the entire characteristic symptom-complex. This certainty of diagnosis extends only to ulcers in the pars media. It has frequently come to pass that a suspected ulcer is found on operation to be in reality of carcinoma. This error has been laid to the niche symptom, when in reality the error in diagnosis could have been avoided. It is the author's belief that ulcer and carcinoma can be distinguished roentgenologically.

An analysis is made of two of the cases reported in the literature and it is shown that the roentgenological findings, when correctly interpreted, are quite satisfactory. Extragastric structures may sometimes give a false impression of niche and these should be guarded against. One example is the presence of diverticulum of the duodeno-jejunal flexure. Prepyloric gastric diverticula have also been reported as giving rise to niche in the roentgenogram.

An ulcer niche and a primary carcinoma can be fully distinguished after sufficiently exact observation of the changes of the descending lower segment. The distinguishing features in the small curvature in gastric ulcer are: (*a*) straight course, more or less restricted around

the niche; (*b*) sharply and uniformly contoured; (*c*) peristalsis usually retained. In the case of carcinoma we find: (*a*) the small curvature drawn in deeply and often recessed in a stepwise manner toward the cardia; (*b*) the contour is usually irregular and indistinct (this feature is less marked in scirrhous than in fungous carcinoma); (*c*) stiff and without peristalsis especially in scirrhous infiltrations).

The point of origin of the shadow in the case of gastric ulcer is (*a*) wholly or partly outside the profile line; (*d*) it is semicircularly sickle-shaped; (*c*) it is set off by a narrow neck; (*d*) the immobility and retention of the deposit are appreciable; (*e*) gas bubbles are often present. The point of origin in the case of carcinoma has the following characters: (*a*) it is within the profile line; (*b*) it is spur-shaped and of irregular outline; (*c*) it possesses a broad base; (*d*) the immobility and retention are slight; (*e*) gas bubbles are very rare.

In the large curvature the gastric ulcer shows the niche as very narrow, running horizontally and bounded by straight lines; while carcinoma shows a broad indentation, irregularly outlined and often running diagonally. The gastric folds in the case of gastric ulcer are arranged radially around the niche, while in the case of carcinoma they are irregular.

During the past four years 27 resections of the stomach have been carried out following a roentgenological examination by the author, and in all of these cases the macroscopic and microscopic observations confirmed the diagnosis of gastric ulcer. In 4 similar cases a gastroenterostomy was performed and here also the ulcer diagnosis was confirmed. In not a single one of these cases was there a carcinoma. It is claimed further that no cases operated on for carcinoma showed the presence of a simple ulcer alone. Chronic gastric ulcer may undergo malignant degeneration and experience seems to show that a mere clinical study is unable to determine when this degeneration has occurred. The occurrence of the slightest indistinctness in the characteristic ulcer niche should be regarded as a suspicious warning signal of possible carcinoma. In the case of duodenal ulcer and of ulcer of the middle portion of the stomach it is safe to await further developments, but if this suspicious degenerative change is observed in the pyloric region the danger is sufficiently great to demand active treatment.

Hellmer, Hans. Patella partita. *Acta radiol.*, 1925, iv, 137–145.

During the latter part of 1923 three cases were observed roentgenologically in which the patella was found to be separated into two or three parts. This anomaly has been reported in the literature under the name of patella bipartita and patella tripartita. The first case occurred in a woman aged twenty-five, who had received several small injuries on the right knee. The left knee appears never to have been subjected to trauma. The roentgenogram of the left knee showed the patella in normal position and consisting of two segments separated by a zone about 3 mm. wide. The two segments were quite parallel and fairly sharp. The rest of the knee showed no important changes. The right patella was found to be in three fragments divided by practically straight zones and lying practically parallel to each other. This knee also showed no other important changes.

The second case was found in a man aged fifty, who received a hammer blow on the left knee. The roentgenogram of this knee showed two small bony structures with smooth contours lying near the patella and apparently representing free joint bodies. The joint capsule was very much swollen. Operation disclosed at the lower surface of the lateral femoral condyle two defects in the cartilage similar to those seen in osteochondritis dissecans. The two bodies seen in the roentgenogram lying at the lateral edge of the patella could be distinctly palpated at operation, but were immovably fixed in the joint capsule. The roentgenogram of the same knee taken about two years later showed it to be separated into three fragments similar to those seen in the first case. The femoral and tibial joint surfaces were somewhat flattened and their contours showed small irregularities. There were no roentgenological signs of cartilage destruction. The right knee showed normal structure.

The third case occurred in a man aged twenty-three who had received trauma of the right knee. The roentgenogram showed the lateral portion of the patella separated from the rest of the bone by a zone about 2 mm. wide running vertically and somewhat curved. This separation was only partial. In the left knee there was a distinct separation of the patella into three fragments similar to those described above. There were no other pathological changes visible in the knee joint.

Hofmann, Ottokar, and Ewell, George Hobert. Hirschsprung's disease, or congenital megacolon. *Arch. Surg.*, November, 1925, xi, 674–683.

The diagnosis of megacolon in infancy or in childhood should not be difficult. A carefully taken history and physical examination can rule out the conditions simulating it, such as rickets, chronic indigestion with constipation, acute intestinal obstruction or tuberculous peritonitis. In the adult the conditions from

which it must be differentiated are certain forms of chronic ileus, annular forms of carcinoma of the intestine, ovarian cysts, dysenteric ulceration and tuberculous peritonitis. In each instance the history, physical and roentgen-ray examinations should enable one to arrive at a diagnosis.

Dilatation of the sigmoid alone has been present in most of the cases reported. Unlike ordinary cases of obstruction the cecum is not ballooned out nor is the small bowel dilated. Great increase in the circumference of the bowel is noted and a lengthening is also present. The distended bowel contains a large accumulation of gas and fecal matter. The folds of the mucosa are considerably flattened and the haustral marking is usually lost. The bladder may be enlarged, the liver pushed to the right and the diaphragm pushed upward. Disturbances of circulation resulting from pressure on the vena cava are common.

The treatment of megacolon is both medical and surgical. It would appear, however, that the results from any plan of treatment are not very encouraging. It is believed that early diagnosis, followed by prompt surgical intervention offers the best chances for success.

A report is given of a case occurring in a boy aged eight, complaining of constipation, with an enlarged abdomen. The enlarged abdomen was observed eight hours after the child's birth and has persisted ever since. Roentgenograms showed that the stomach was enlarged to twice the ordinary size for a boy of eight years, and because of the enormous distention of the colon, the stomach was displaced to the right causing a distinct angulation at the pylorus. The cecum was dilated to almost twice the ordinary size. The first part of the transverse colon appeared to be relatively constricted at its junction with the middle third and the remainder of the transverse colon, and the descending portion appeared to be distended to about six times the normal diameter. The sigmoid flexure showed no abnormality and the rectum appeared normal. Appendectomy and cecostomy were performed. On the thirteenth day the abdominal distention suddenly recurred accompanied by dyspnea and cyanosis. The heart action became feeble and death followed.

Jaksch-Wartenhorst, R. Cardiac aneurysm in the roentgenogram. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 563–564.

In a case of acute productive pulmonary tuberculosis the roentgenoscopic examination of the heart revealed peculiar features which at first could not be explained. In the region of the heart apex there was a shadow thickly calcified and pulsating synchronously with the heart. This was of about the size of a walnut and appeared to be intrapericardial. This irregularly spherical shadow had a pronounced and peculiar motion. There was a definite movement downward and outward, and there was at the same time a distinct rotatory movement. These were best covered in the ventrodorsal view. The peculiar nature of the motion led to the conclusion that this was not a structure adherent to the heart but represented rather a structure lying within the pericardial sac and in close contact with the heart muscle, originating either in the pericardium or myocardium.

The autopsy disclosed an aneurysm of the heart apex with calcified thrombi in a fibrous myocarditis of the apex, and circumscribed adhesions of the aneurysm with the pericardium.

Jansen, J. W. F. A case of unilateral chondromatosis (Ollier's disease). *Acta radiol.*, 1925, iv, 133–136.

A case of unilateral chondromatosis is reported in a nine-year old girl. All the tumors were located on the left side, while on the right there were a few small suspected patches. Microscopic examination of the pathological tissue showed it to consist of cartilaginous cells of myxomatous type with fibrous tissue entirely absent. In the midst of the cartilaginous masses there could be seen bone marrow cells and blood vessels.

Pathological symptoms of the sympathetic system were not manifest. The face was asymmetrical, but as the left side of the body was less developed than the right this retarded development of the face must not be given too much importance.

Jordan, Alfred C. Peribronchial phthisis. *Brit. J. Radiol.*, 1925, xxx, 460–461.

It is essential for every roentgenologist to recognize the nature and origin of the pulmonary shadows seen in healthy persons, or he may fall into the common error of attributing them to "hilus" or "perihilus" disease. The blotches and lines are compatible with normal health, and their size and density are no proof of active disease. Mottling is the only sure sign of active disease in the lungs. This is produced by microbes in the peribronchial tissues surrounded by groups of leucocytes assembled in the defense against the invaders.

This fine peribronchial mottling is characteristic. It is disposed radially about the small bronchioles, commencing at the level of the roots just external to the root glands. If the disease is progressing, the mottling may be

traced radially outward, upward and downward. The root glands begin to enlarge, and they continue to enlarge as long as the mottling increases in extent. At any stage healing may commence and leave its permanent record in the form of fibrous tissue about the air tubes and the bronchial glands.

It is the author's conviction that the mottling is never tuberculous at first. It is always micrococcal; the tubercle bacillus gains a footing after the tissues have begun to break down under the strain of the micrococcal invasion. The same thing occurs in joints. A "white swelling" of the knee is not necessarily tuberculous. It is not possible to decide precisely when the tubercle bacilli have begun their invasion.

Kerley, Peter. Neoplasms of the lungs and bronchi. *Brit. J. Radiol.*, 1925, xxx, 333–349.

In all cases of carcinoma of the lungs early and accurate diagnosis cannot be too much insisted upon. The commonest mistake is to diagnose these conditions as tuberculosis and prevent the patient from receiving the only rational treatment known, namely, deep irradiation. As far as the metastatic forms are concerned, it is advisable before operation to screen the lungs of all patients suffering from malignant disease and also all cases of brain tumor occurring in an unusual situation. Bronchial carcinoma occasionally gives rise to no local symptoms but has a peculiar tendency to widespread metastases, the brain being a favorite locus.

An accurate clinical picture of malignant disease of the lungs cannot be given. The first symptom to attract attention is loss of weight, which is usually severe and out of all proportion to the physical signs. Hemoptysis is a frequent and very valuable sign. The physical signs may be very anomalous and depend entirely on the situation and distribution of the growth in the lung. Some of the signs suggest pneumonia and others tuberculosis, depending upon the location of the tumors. A pleural effusion is a very common complication. If it recurs and is blood stained, it is suspicious but by no means diagnostic. The roentgenogram gives, within limits, fairly characteristic pictures. The author proposes a classification which is an elaboration of Otten's: Type I is the pneumonic type of bronchial carcinoma. This is the most usual appearance given by bronchial carcinoma on the roentgenogram. The lobe affected (as a rule the upper) appears as a moderately dense shadow, invariably sharply limited by the interlobar fissure. The shadow is rarely dense enough to obscure that of the ribs and this coupled with the fact that the border is sharp and the position unusual is against the possibility of fluid. The difficulty in diagnosis lies in differentiating this type from chronic pneumonia or actinomycosis. Two cases illustrating this form are described.

Type II is the hilum form of bronchial carcinoma. This is not so common as the previous one but gives a far more typical picture. The hilum is very dense and enormously enlarged, often appearing five or six times its normal size. Its shape resembles a semicircle from which run fine, grayish, wavy striations into the lung giving the appearance aptly described as woolly infiltration. These striations are due to malignant infiltration of the perivascular and peribronchial lymphatics. A differential diagnosis has to be made from mediastinal tumor and hilum tuberculosis. One case of this type is described.

Type III is the nodular type of bronchial carcinoma. This is relatively rare, but diagnosis is not very difficult. Large, rather sharply outlined nodules are seen on one side of the thorax and they communicate with the hilum through thin or thick dense shadows. The possibility of these nodules being metastatic is the first consideration, but they are not so sharply outlined as metastases, and the dense peribronchial infiltration associated with them absolutely rules out the question of their being secondary foci. This condition must be differentiated from syphilis of the lungs, which may cause difficulty. A case illustrating this type is described.

Type IV is an exceedingly rare form of lung carcinoma or sarcoma and is known as the cavernous type. The presence of a huge solitary cavity in one lung should always lead to suspicion, and if some slight tuberculous manifestations are seen in striking contrast to the huge cavity it by no means necessarily follows that the cavity is tuberculous. The differential diagnosis is practically impossible from phthisis or abscess of the lung, but there are two points which may help: (*a*) on a good plate very fine striations, dense and net-like may be seen running to the hilum. these are the invaded lymphatics. (*b*) If a tuberculous or abscess cavity contains fluid, the level varies considerably from time to time as the contents of the cavity are coughed up. This form of malignancy does not communicate freely with the bronchus, tending rather to grow like a metastasis, and as a result the fluid level is often constant over a long period.

Type V includes isolated metastases. These are more common than the disseminated type and give the same picture always, irre-

spective of the nature or position of the primary growth. The appearance is that of a round or oval dense shadow sharply outlined from the neighboring lung tissue. These metastases are far commoner than is generally believed. The author considers it quite impossible to differentiate between echinococcus cyst and lung metastasis.

Type VI includes carcinomatosis of the lungs. In this the disseminated form of metastasis is frequent, and great difficulty can arise in the differential diagnosis from miliary tuberculosis. If it is one of the exceedingly rare cases of hematogeneous disseminated carcinoma the differential diagnosis can only be made in the post mortem room. The more common lymphogenous type also presents difficulty but a close examination of the plate will show that the nodules are perhaps a little bigger than miliary tubercles and that there is over the whole of both lungs a fine, net-like structure. A useful diagnostic point is the fact that the nodules are usually limited to the lower two-thirds of the lung field. Two cases of metastases are cited.

KEY, J. ALBERT. The non-tuberculous hip of early life. III. In adolescence. *J. Missouri M. Ass.*, December, 1925, xxii, 457–461.

As far as the hip is concerned, the period of adolescence may be considered as beginning at about the eleventh year and lasting until the head and neck of the femur are united by bone at about the nineteenth year. The conditions most affecting the hip in this period are traumatic lesions, developmental defects, neoplasms and pseudarthritis.

Epiphyseal coxa vara is the only traumatic lesion discussed, because the effect of trauma on the hip is determined by the anatomy of the hip rather than by the type of trauma. Certain traumatic lesions are characteristic of each age. During adolescence the thickened periosteum of the neck gradually atrophies to that of the adult, and the attachment of the head to the neck is consequently weakened. The result is that the point of least resistance lies in the epiphyseal line. The thickening of bone is more than adequate to overcome the slight loss in mechanical efficiency due to the increased length of the neck, and so fracture of the neck of the femur in adolescence very rarely occurs. The same is true of traumatic dislocation. As a rule, when the hip of an adolescent is subjected to trauma it is either not injured or it yields in the epiphyseal line, and the head of the femur slips downward and backward on the neck causing an epiphyseal coxa vara. The latter condition is, however, by no means a purely traumatic lesion, as many of the cases give no history of injury. Furthermore, about 20 per cent of these patients have both hips affected. The exact nature of the insufficiency in the hip is unknown. The symptoms in this disease vary in acuteness from time to time and are usually relieved by rest. The roentgenogram shows the abnormal relationship between the head and neck of the femur. The head is displaced downward and backward on the neck and the posteroanterior border of the end of the neck is usually embedded in the epiphyseal surface of the head. The degree of displacement of the head varies in different cases and may progress over a period of months or years until a very slight slipping is converted into a complete displacement of the head. The deformity of the hip in adduction and external rotation is almost pathognomonic. Many such cases are diagnosed as tuberculosis of the hip and treated as such.

One of the developmental conditions affecting the adolescent hip is coxa valga. This may be defined as a condition of the hip in which, with the head of the femur in its normal position, the extremity is maintained in a position of abduction. Almost without exception the condition is due to an increase in the angle between the neck and shaft of the femur. Coxa valga may be divided into primary and secondary types. Primary or idiopathic coxa valga is a rather rare condition and probably congenital, although it is, as a rule, not noticed until adolescence. There is no pain nor a definite limp. The condition is often bilateral and the patient sways from side to side in walking. The diagnosis is difficult and as a rule is not made unless a roentgenogram is taken of the affected hip. The roentgenogram shows the deformity in the neck of the femur. The normal collo-diaphyseal angle is 120° to 130°. In coxa valga the angle is 140° to 170°.

Symptomatic coxa valga develops in hips which for any reason are deprived of the weight-bearing function during the growing period. The most frequent cause is infantile paralysis.

Closely allied to coxa valga in symptoms and not infrequently associated with it, is an incomplete dislocation of the hip. In this condition the head is not completely out of its socket but rides upon the posterior-superior border of the acetabulum. The condition is quite rare and probably a congenital deformity. The diagnosis is made from the roentgenogram which shows the minor displacement of the head of the femur. The treatment is rest and exercise, with support to the hip.

Bone tumors may of course occur in adoles-

cence. Sarcomas are rare in the region of the hip. Benign bone cysts, however, occur more frequently in adolescence than in any other age period and a not uncommon localization is in the upper end of the femur. The only symptom may be moderate pain in the region of the hip. Sometimes the first symptom is a pathological fracture and the bone cyst is diagnosed in the roentgenogram of the fracture. A characteristic roentgenogram shows a rarefied area in the medulla of the long bone which may extend up to the epiphyseal line, but does not invade it. The cortex may be thinned and expanded but it is not perforated. In the healing of a pathological fracture due to a bone cyst, the cyst is often cured. Radical incisions and amputations are unnecessary mutilations. Hence the possibility of a cyst should be excluded before such operations are performed for the treatment of bone tumors.

The arthritic lesions of the adolescent hip do not differ materially in the clinical picture from those of childhood. An acute suppurative condition in the region of the hip in an adolescent is more often an arthritis than an osteomyelitis, while in childhood the reverse is true. These suppurating hips in adolescence are apt to heal very quickly with a bony ankylosis.

By pseudarthrosis of the hip is meant any condition which simulates a lesion in the joint but in which the joint is normal. Owing to its deep-seated location the hip is not infrequently suspected, when the disease is elsewhere. The inflammation may be in the soft parts or in the bone. The bone lesions are an osteomyelitis of the pelvis, usually the ilium, or of the upper end of the femur, or an epiphysitis of either the greater or lesser trochanters. The lesions of the soft parts can usually be diagnosed by the local swelling and tenderness. The bone lesions are more difficult to diagnose. In the early cases the roentgenogram is negative and with the patient often acutely ill, early operation is imperative. With the lesions in the trochanter, the patient is usually not acutely sick. The epiphysitis is usually due to an organism of low virulence and diagnosis is only possible after some weeks when the roentgenogram shows new bone formation about the focus.

Among the cases of pseudarthritis of the hip may be included hysterical hips, which are rare. The diagnosis is difficult and should be made with caution. In the hip, the deformity is apt to vary from day to day and the distribution of pain is atypical. As a rule there is no objective sign of disease other than fixation of the joint. In cases of long duration, atrophy and contractures may develop. The pseudarthritic conditions are not limited to adolescence but may also occur in young children.

ROENTGEN AND RADIUM THERAPY

Finzi, N. S. The use of radium in combination with *x*-rays and surgery. *Brit. J. Radiol.*, 1925, xxx, 430–432.

In order to get a satisfactory amount of radiation to a tumor, it is necessary to apply such a dose that parts of the tumor around the radium tube or needle receive a very considerable over-dose. This does no harm if the wound is kept aseptic. There must be a zone of tissue, however, which receives a true lethal dose, and since twenty times the lethal dose will still give some immunological protection there may be a considerable zone which after absorption of the radiations acts as a protective agent against the remainder of the living part of the tumor. This might possibly have a reflex action on malignant cells so as to render them susceptible to smaller subsequent doses of rays. If this be true, it is a strong argument against the homogeneous dosage of tumors. Using this as a working hypothesis, it seems not unreasonable to treat the main mass of the tumor by radium needles and deal with the outlying areas and glands by a dose as nearly as possible homogeneous, either of roentgen rays or radium, trusting to the effect of this combined with the protective effect from the absorption of the other part of the tumor.

The combination of roentgen rays and radium finds a particularly useful field in the treatment of carcinoma of the uterus. This combination is often useful in growths of the mouth and throat, but in many cases it may be just as good or better to use diathermy for the local growth and radium or roentgen rays for the glands. A very good method in these cases seems to be a preliminary treatment with penetrating roentgen rays followed by diathermy either within a few days or, if the roentgen dose has been large, six weeks later. In the former case a second larger dose of roentgen rays is given later on.

Surgery has often been used to remove portions of the maxilla to prevent its necrosis after radium treatment. The author believes that this method is theoretically unsound, nor does he approve of the use of surgery to remove part of a growth before treating it with radium. The growth forms an excellent medium in which to place the radium needles and if the growing edge receives a sufficient dose the remainder will be absorbed. On the other hand, something might be done by exposing tumors and bringing them to the surface, cutting them in half and giving an over-dose of roentgen rays to the cut halves so that the growing edge will receive the correct dose.

GINSBURG, SOLOMON. Osteoplastic skeletal metastases from carcinoma of the breast *Arch. Surg.*, August, 1925, xi, 219–236.

Skeletal metastases may be present at least nineteen years after a carcinoma of the breast has been removed without any evidences of local recurrences. Osteoplastic skeletal metastases usually pursue a rather slow course and frequently give rise to an inflammatory reaction that may simulate very closely an ordinary benign non-neoplastic process. Remissions may occur in all forms of carcinoma and are especially liable to occur in the osteoplastic type of skeletal carcinomatosis.

When a diagnosis of skeletal carcinomatosis is definitely established, it does not invariably mean that the patient will succumb to the disease in a few weeks or months. Therefore one must not immediately resort to the use of morphine and habituate the patient long before this becomes absolutely necessary. Roentgen therapy intelligently and persistently applied and re-applied in carcinomatosis is a powerful agent for producing analgesia, palliation and prolonging life in relative comfort.

A detailed presentation is given of a case observed in a married woman, aged fifty seven, who had had a right mastectomy in 1904. The present illness dates back to 1916 when the patient began to suffer from bilateral dental neuralgia and frequent, recurring, occipital headache. The only positive findings at examination were in the skull where three bony masses 1 to 2 inches in diameter were felt. The tumors were neither tender nor painful. There was slight edema of the forehead extending to the upper eyelids. The roentgen-ray examination of the skull showed a diffuse increase of bone formation with a small area of destruction. The roentgenological diagnosis was positive typical gumma. The Wassermann reaction was negative.

The case was exceedingly puzzling and a further examination by experienced internists led a majority of them to offer the diagnosis of syphilitic bone disease. When a suspicion of bone malignancy was expressed it was discarded as an utter improbability. The clinical course was so like that of a benign inflammatory condition that all suspicion of a carcinomatous bone lesion was completely warded off.

The condition became worse and finally a biopsy of the skull was performed. The pathologic report came back adenocarcinoma. The patient was bed-ridden and in miserable condition from continued morphine medication. Consent was finally obtained to the application of high voltage roentgen-ray therapy. The technique used was 200 kv., target distance 50 cm., filtered through 0.5 mm. Cu plus 1 mm. Al, 4 ma., portal 15 × 15 cm., for 90 min. (skin erythema dose). This dose was repeated over each field in four to six weeks. After this treatment the patient felt improved. Pain had decreased and appetite and strength were improved. In addition to this symptomatic improvement the nodules over the skull were distinctly diminished in size and finally almost disappeared.

The roentgen therapy was discontinued for four months and there suddenly developed severe pain in the left shoulder and the cervical spine. Another course of high voltage roentgen therapy caused gradual relief from the pain, swelling and disability. The nodules in the skull, which had begun to grow again, once more yielded to the roentgen-ray therapy.

Several months later there developed dull pain in the sacral region but the roentgenologic examination failed to reveal any gross pathologic changes in the lumbar spine or the pelvic bones. The cervical spine showed no progressive destructive change. The skull disclosed an increase of new bone formation. The patient received another series of roentgen-ray treatments which finally completely relieved her of the pain and disability. It is true that the onward course of this patient's illness had not been stopped, but the moderate analgesia and prolongation of life achieved by roentgen therapy is clearly demonstrated.

HANDLEY, W. SAMPSON. The encirclement method of using buried radium tubes. *Brit. J. Radiol.*, 1925, xxx, 422–429.

There are three erroneous assumptions which vitiate much radium treatment. The first is that any lump or nodule of malignant tissue is homogeneous throughout, requiring therefore a uniform intensity of radiation throughout the block of the tissue to destroy it. The second fallacy is that the extent of a given single focus of malignant tissue may be mapped out by the coarse methods of inspection and palpation, i.e., by clinical examination. The third fallacy is that the extension of the focus occurs equally in all directions. The destruction of the visible or palpable lump of malignant tissue is not of as much importance as the arrest of the spread of the disease. The latter is the principal object to aim at and it is often sacrificed to the pursuit of the minor object.

It is often assumed, and quite erroneously, that the palpable edge of the tumor mass marks out the area requiring radiation. Beyond this edge in most cases there is a second or infiltrative edge, a zone the diameter of which considerably exceeds the diameter of the palpable mass. To ignore this zone is one of the funda-

mental faults of radium therapy. In addition there is the danger of lymphatic invasion. It is therefore best usually to ignore altogether, for the time being, the visible deposit and to direct treatment entirely to the microscopic zone of infiltration surrounding. These considerations form the basis of the encirclement method of treatment advocated and practised by the author for some years.

Thus far, the author claims to have established that radiation should be concentrated just outside the palpable edge of a malignant nodule. Infiltration has a strong preference for extension in the loose cellular tissue. In the case of a nodule beneath the skin, the plane of maximum infiltration will be in the midplane of subcutaneous fat. This therefore is the plane of choice in which radium tubes should be placed so far as infiltration is concerned. The plane in which permeation spreads is the plane of the main lymphatic plexus draining the skin and subcutaneous tissues, i.e., the plane of the deep fascia. Extension in planes at right angles to the skin, though possible, may be ignored. The sole object of the first encirclement treatment should be the arresting of permeation and infiltration in the apparently healthy but actually infected tissues surrounding the palpable nodule. In fact, the nodule itself will often receive incidentally sufficient radiation to destroy it. If not, then six weeks later a direct attack should be made upon the nodule itself.

The details of the treatment as applied in 4 illustrative cases are described.

Holfelder, Hans. The appropriate time distribution of the roentgen dose; "the problem" of radiation therapy. *Arch. f. klin. Chir.*, 1925, cxxxiv, 647–662.

We are not justified in generalizing the numerous problems of radiation therapy according to a single scheme. Each individual aspect of the problem should be solved separately after a careful study of the biological peculiarities of the particular phase. There is great need for a careful determination of the best times at which divided doses should be administered in the various diseases amenable to irradiation. The divided doses meant by the author are not those in which a total dose is distributed over several successive days, only to be repeated after a pause of several months. The division of dosage here referred to applies to the procedure in which irradiations are administered at regular intervals of about every two to four weeks.

Such a plan of distribution of dosage appears to be entirely out of place in the treatment of carcinoma, for two reasons: (1) the possibility of rendering the carcinoma cells resistant to the rays, and (2) the production of roentgen injuries. On the other hand, the plan of divided dosage seems to be very promising in the prophylactic postoperative irradiation of breast carcinoma as compared with large irradiations given at one sitting. The work of Jüngling has provided a sound experimental basis for the application of divided doses in postoperative prophylactic treatments. The fundamental action of roentgen rays on carcinoma cells is a direct local cell-destroying effect. It would appear that some carcinoma cells are in what might be termed a quiescent stage and therefore less vulnerable to the radiation. These are the cells which, if left undisturbed, may cause recurrences and it is these cells which the divided method of dosage is intended to destroy.

Hazen, Henry H. Lessons learned from failures in the roentgen-ray treatment of cutaneous cancer. *J. Cancer Research*, September, 1925, ix, 404–407.

A consideration of the facts observed would seem to indicate that the usual doses of roentgen rays do not directly kill the cancer cells, but stimulate certain defensive reactions in the tissues. One of the defensive mechanisms is a local reaction, but there is good reason to believe that there may likewise be some general immune process concerning whose nature we are still ignorant. From the practical standpoint pre-operative irradiation has a scientific basis. In treating cutaneous neoplasms by either roentgen rays or radium, care should be taken that there be a fairly wide margin of normal tissue exposed in order that the defensive reaction be established. Cancer invading cartilage or scar tissue cannot be satisfactorily dealt with by irradiation.

Holst, Leopold. On the roentgen treatment of cutaneous leishmaniasis (oriental sore). *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 709–713.

In the therapy of oriental sore it should be remembered that the process very frequently heals spontaneously, although this may take a long time and always produces large contracted scars. It has been claimed that active local treatment may make the condition worse. Arsenicals have been claimed to be effective by Behdjet in 4 cases, complete cure being obtained in fifteen to twenty days. Radium seems to be of no promise in this condition. On the other hand, the literature contains several reports on the successful use of roentgen rays.

Since skin leishmaniasis consists essentially of a granuloma,—the histological structure of

it in chronic cases suggests a tuberculide,—it seems that roentgen rays should be helpful.

The first patient treated by the author was a man who had had the disease for two years and presented a large sore on the right cheek. He received a dose of 5 H filtered through 3 mm. Al, which dose was repeated three weeks later. Following each treatment there was a certain amount of irritation of the sore. These symptoms set in about eight to ten days after treatment but disappeared shortly and the general condition then improved. The next treatment three weeks later consisted of 6 H filtered through 2 mm. Al, the irritation resulting being somewhat stronger but the subsequent improvement better. A slight pigmentation appeared on the previously reddened skin. The fourth treatment was given three weeks later and consisted of 4 H filtered through 2 mm. Al. There was no longer any irritation and epithelization progressed very rapidly. The end result was a slight reddening of the skin but no scar was noticeable and the pigmentation was diminished. A recidive was feared, and a fifth irradiation was administered causing the small nodules to disappear completely. When seen two years later the patient showed only a very slight pigmentation of the skin without a sign of scar.

In a second case, more suitable dosage was applied and a cure was obtained in a still shorter time. The first dose was 4.5 H through 3 mm. Al; the second 6 H through 2 mm. Al; the third and fourth treatments 4 H through 2 mm. Al, treatments at intervals of three weeks. The end result was excellent.

HUDSON, R. V. Skin and tumour reactions and their bearing upon radio-therapy. *Brit. J., Radiol.*, 1925, xxx, 432–443.

The treatment of malignant disease with radiation is a very complex matter. It is upon the sublethal dose and its power to produce a culminating effect upon the tumor cells that the radiotherapist must often depend. But this power of the sublethal dose to establish and maintain a mastery which eventually causes the death of the tumor cells is limited by the total amount of radiation that can be tolerated by the skin and the deep structures. If the culminating dose establishing tumor mastery lies within the range of the culminating dose producing the skin damage, success should follow its application. If this tumor dose exceeds the range of skin tolerance treatment will be unlikely to succeed.

There is no doubt that methods of irradiation can be improved upon and must of necessity be modified according to the site of the tumor and the type of radiation. It is suggested, however, that a maximum efficiency can be obtained only by the avoidance of tissue damage, and that always the greatest hope of success lies in its avoidance and the maintenance and enhancement of the normal tissue immunity toward the malignant process.

A method is described by which the maximum amount of radium radiation capable of being supported by the skin can be obtained. This is based upon experiments made for the most part upon the skin of the rat and upon Jensen's rat sarcoma. An irradiation which is of sufficient strength to elicit a skin response detectable clinically and designated as a "reaction" is considered a comparatively severe dose and should be looked upon as traumatic. A "reaction" is a clinical warning of the severity of the dose, and it must not be assumed that because nothing is taking place visibly on the surface of the skin there is nothing going on in it, beneath it or in a region remote from the portal of entry.

HUECK, HERMANN. The radiation treatment of sarcomas. *Arch. f. klin. Chir., Berl.*, 1926, cxxxix, 607–615.

Sarcoma irradiation belongs to the most disputed field in roentgen therapy. Bad as are the results from surgery in general, the end results from radiation therapy are no better. The histological constitution of the connective tissue tumors gives no definite basis for judging their vulnerability to radiation therapy. In the years 1920 to 1925, one hundred sarcomas were treated in the surgical clinic of the University of Rostock. Some of these refused completion of the roentgen treatment, and there were others who could not be followed up as to end results. There remained 55 cases (36 males and 19 females) upon whom the following report is based.

Ten of the cases received roentgen therapy exclusively; 24 underwent an incomplete operation preceding roentgen therapy; in 15 there was radical removal of the tumor followed by roentgen irradiation of the field of operation; 6 cases had previously undergone radical operation and these received radiation treatment of the metastases.

The irradiation consisted of 70 to 80 per cent of the skin unit dose as a first treatment in all cases, except the lymphosarcomas. However, a full skin unit was often begun with, especially in bone sarcomas. The subsequent plan of irradiation depended naturally upon the location of the tumor and the clinical condition. Moreover, the technique changed from time to time. The application of homogeneous irradiation with the aid of paraffin or plastine casts is considered very useful. The aim in general

has been to administer 80 to 100 per cent of the skin unit dose upon the tumor in each of three applications. This was followed by an interval of several months to permit recovery of the skin before a second series was attempted. The rays were filtered through 0.5 mm. Zn plus 1 mm. Al; the size of the field and skin focal distance varied.

So far as regards the primary effect of the rays upon the tumors in this particular group, the results appear to be the same as those reported previously from other clinics: 38.5 per cent disappeared, 36.5 per cent diminished in size, and 25 per cent remained uninfluenced. This is based on 44 cases, the remaining 11 having had their tumors completely removed surgically as mentioned above. During the past five years 33 of these cases have died, and 3 irradiated during the past year already show recurrences; of the remaining 19, eight must be left out of consideration because they have been under observation only a year and a half or less. There remain 11 cases with a favorable result lasting from two to five years and showing complete disappearance of the tumor without sign of recurrence or metastases. This means a 20 per cent successful result. Undoubtedly this value will diminish as the five-year period becomes extended to all the cases. The above 11 cases, however, include 5 that had undergone radical operation. This leaves only 6 cases in which the disappearance of the tumor may be ascribed to the roentgen rays. Of these one has remained cured five years; 4 for three years and one for two years.

Brief descriptions are given of the 11 successful cases.

Kienböck, Robert. Roentgen therapy of carcinoma. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 679–682.

The following prerequisites are necessary for favorable results in roentgen treatment of carcinoma: (1) sufficient vitality and radiation sensitiveness of the tumor tissue in the strict sense (that is, cancer cells, sarcoma cells), so that the cells as a result of irradiation suffer very sharply in their life processes, especially proliferation; (2) favorable anatomical and biological constitution and good vitality, moreover—in relation to the tumor cells—lower radiosensitiveness of the stroma (interstitial tissue), i.e., there should not be present any irritative conditions nor disturbed circulatory relations; (3) similar properties of the surrounding healthy or merely hyperplastic (adenomatous or strumous) but not malignantly altered remainder of the organ, or of the tumor substrate; (4) a similar constitution of the regional structures surrounding the organ with the tumor; (5) a healthy or at least not very much diseased general organism, above all a favorable set of hematopoietic organs (the bone marrow, etc.), of the circulatory apparatus (the heart and vessels) and of the kidneys.

In those cases which show a pronounced proliferation of the tumor following irradiation, it is not to be assumed that there has been a direct stimulation of the tumor by the rays. On the contrary, the effect is due to an injury of the interstitial tissue of the host so that the tumor encounters less resistance in its development. Such an injury of the host's tissue is a sign of over-exposure to roentgen rays. This over-exposure may be merely a relative condition where an unfavorable set of the normal structures makes them equally or more sensitive than the tumor cells; or the over-exposure may be an absolute one due to a real excessive over-exposure of an ordinarily favorable tumor structure. The author regards the views of Seitz and Wintz as partly erroneous because these authors have not taken account of the above-mentioned factors.

The rationality of the "carcinoma dose" proposed by Kroenig and Friedrich does not seem to have a very sound basis when considered in the light of the concepts outlined above. The Erlangen Clinic has recommended a single intensive irradiation in the treatment of deep-lying carcinomas. This procedure should be recommended only in those cases in which it is expected that a complete radical cure will be obtained. In all other cases the the application of a conservative series of treatments with distribution of the irradiations over a prolonged period is far preferable both in the effect on the tumor and in the avoidance of injurious side effects upon the patient. The intensive procedure leads not infrequently to a relative or indeed an absolute over-exposure of the tumor area so that the tumor may proliferate more actively and the result of such treatment in many cases is an invasion of the body, leading to premature death.

Kisch, Eugen. Conservative treatment of bone and joint tuberculosis. *Strahlentherapie*, 1925, xx, 499–522.

The exclusive operative treatment of bone and joint tuberculosis has several important disadvantages, the main ones being that only the visible foci can be removed and the procedure permanently cripples the patient. The most important criticism against surgery is that it ignores the fact that so-called surgical tuberculosis is a general and not a local disease.

The most important element in the therapy of this condition is the general treatment, supported, of course, by such local measures as are necessary. In the handling of the local tuberculosis condition the treatment should not be exclusively surgical not conservative, but should include the forms of therapy that avoid as much as possible a maiming of the patient. It is however, to be remembered that it is not possible to treat all cases without making use of surgery.

The general treatment consists in a systematic exposure to air and sun. The general effect of this form of treatment is to ease pain, induce temporary increase in the elimination of pus from fistulas, and to lessen the probability of the formation of secondary abscesses. The technique of heliotherapy in diseases of the bones, joints and glands is described in detail and consists of gradually increasing exposures of the tuberculous foci and various portions of the body.

The main contraindication to heliotherapy was assumed to be an intercurrent pulmonary tuberculosis. Since there is no clinical or roentgenological method for determining the tendency of a tuberculous process to hemoptysis it was believed to be unsafe to expose such a patient to the strongly hyperemic action of the sun. The author has for the past five years extended heliotherapy to cases of pulmonary tuberculosis. Emphasis is laid upon the value of several pauses in the sunlight treatment to permit decline in the hyperemia produced. The scheme for sunlight treatment of pulmonary tuberculosis is given in detail. A large number of cases with cavernous lungs have been thus treated and not a single hemoptysis has resulted from the sunlight cure.

Considerable use has been made of roentgen therapy for the past two years. It has not been employed independently or as the main form of treatment, but as a support to the various other procedures. The roentgen treatment is given in divided doses. Experience with numerous cases leads to the conclusion that the employment of roentgen rays in combination with other forms of treatment has shortened the time of treatment by at least a third. The roentgen technique is not described.

Leddy, Eugene T. The routine use of high voltage (editorial). *Radiology*, January, 1926, vi, 71.

In spite of enthusiastic claims for the superiority of homogeneous radiation, clinical results have not justified its universal use; in fact, in many places the enthusiasm for high voltage is waning and in practically all clinics roentgenotherapy is advancing away from its status as a physical concept toward that of a bioclinical concept.

Tissue reactions are being watched and the biochemical effects of rays of short wave investigated. Since the biology of cancer is imperfectly understood, the treatment of a given cancer in a given patient depends rather on clinical experience than on mathematical physics.

We do not know that high voltage will produce results unattainable otherwise; we do know it has a fixed place in the treatment of certain tumors, but to what extent it can replace or augment other therapeutic agents, clinical experience in the future alone can determine.

Morton, J. J. Cancer of the skin. *Arch. Surg.*, March, 1926, xii, 655–714.

From a comparison of the two methods, it seems certain that a combination of surgery and radiotherapy is desirable in every case of cancer of the skin. The primary growth should be rapidly disposed of by electrocoagulation or cautery, thus eliminating one dangerous zone as a focus from which metastases may occur. Roentgen irradiation over the lymph gland area might damage any cells already metastasized and allow a safer surgical removal, preferably by cautery dissection. An ideal method would be to implant emanation seeds at proper points during this operation. Dangerous secondary foci in the glands would thus be removed and the tissues thoroughly treated at the same time by operation. Careful follow-up and postoperative irradiation would complete the treatment of choice.

It is not possible in every locality to have available radium emanation or the men trained in its use; and the fact remains that there are more men with the proper surgical qualifications to carry out the surgical treatment than radiotherapists expert or daring enough to undertake the radiation treatment. For this reason alone, until we have more radiotherapists well trained and the method better standarized, the patient in the average community will undoubtedly fare better at the hands of the surgeon. Wherever possible cooperation between surgeon and radiotherapist will offer the best chance for improved results.

The malignant tissue should be removed whenever possible; no matter how well it is irradiated *in situ*, past experience indicates that the risk of leaving malignant tissue behind should be avoided.

Squamous cell cancers of the scalp and forehead do not require removal of the regional glands; cancers of the face, cheek, eyelid, chin and nose, however, require the removal of the

glands. Growths on the extremities and scrotum are prone to metastasize and the regional glands are frequently involved. The squamous cell growths on the ear may metastasize to the parotid, preauricular or auricular glands or to the glands of the neck.

Twenty-nine cases are reported and pictured.

Newcomet, William S. Control of uterine hemorrhage by the roentgen ray. *J. Am. M. Ass.*, Nov. 7, 1925, lxxxv, 1459–1462.

Uterine hemorrhage of general systemic or local benign origin can be controlled by rather mild roentgen irradiation of such dosage as to leave no perceptible change in the skin over the pelvis. In a series of 60 selected patients only 3 failed to respond to treatment. The results from these extremely mild treatments were equal to those in which heavy doses had previously been employed. It also appeared possible to obtain rather surprising results in checking bleeding without the usual unpleasant after-effects.

In a number of the above cases the effect of the irradiation was only temporary; but in most of the cases treated the amount of bleeding was less. It is felt that where mild irradiations fail to produce a result, heavy irradiation will also fail. It is possible to control the bleeding without causing a cessation of menstruation; but this is not always obtainable, and in women nearing the menopause the control of bleeding is likely to lead to a permanent cessation of menstruation.

The method of irradiation is as follows: The body of the patient is covered completely with a leaded rubber or thin lead plates, and four areas over anterior portions of the pelvis, each 2 in. square are exposed for four minutes at a 10 in. focal distance to rays produced by a current of 4 ma., 8 in. spark gap and filtered through 3 mm. Al. If very little effect is produced by this first treatment a second application on the back is given at the end of three weeks, provided the condition of the patient permits. The same technique is employed except that five areas are exposed on the back, three in the center line over the sacrum and two on the buttocks, in the form of a cross. The next application is repeated in six weeks or two months if needed, with modifications according to the requirements of the individual case. If there is the slightest evidence of tanning of the skin over the pelvis, further treatment is withheld except with great precautions.

Most of the 60 patients treated were cases of metritis, local pelvic inflammation and fibroid tumors. Seven of the cases required but one treatment for control of the hemorrhage, 25 cases required two treatments; and 10 cases required three treatments.

Philipp, E. Long time irradiation of the portio vaginalis with radium. *München. med. Wchnschr.*, Oct. 1692, 15, lxxii, 1769–1771.

In the long time irradiation, the intensity of the rays is naturally milder but the prolonged exposure should reach many more cells in the act of division. In addition, there should be a summation of effects upon the cell colloids, and it may be that this effect of a small quantity of radiation may equal or surpass that obtained by a brief exposure to higher doses. Whether this procedure is an improvement clinically remains for future experience to determine.

The few observations made by the author would seem to show that this method of treatment yields about the same results as treatment with large doses. The latter treatment consists of an intrauterine application with two gold applicators of 2 mm. thickness, each containing 26 mg. radium element. In addition, 90 mg. filtered through 2 mm. brass is introduced into the portio vaginalis. This treatment is continued for twenty-four hours and is repeated in approximately the same manner after eight or ten days. The irradiation is of course modified according to the nature and extent of the cancer. The above outlined method is the treatment practised in the ordinary cases.

The method of protracted irradiation using smaller doses of radium was tried out in carefully selected cases of carcinoma. In this procedure two containers holding 15 mg. of radium element filtered through 2 mm. brass and wood are introduced into the crater of the carcinoma and allowed to remain there for seven days, so that about 5000 mg-hr. are given. This treatment is given only in cases of cervical carcinomas of limited extent. Where the carcinomas are greater in extent the above dose is doubled or tripled, with the applicators as far apart from each other as possible. The total dose is of course limited by the development of tenesmus which frequently may be very severe. One should therefore be very careful about placing the applicators directly upon the posterior wall of the vagina. The primary effect is frequently very striking. Within a few weeks a very solid scar is formed consisting of dense connective tissue.

Observations on excised irradiated tissue and upon microscopic organisms such as amebae and spirochetes show no essential differences in the action of large and small doses

of radium. Whatever effect occurs is largely dependent upon the development phase of the irradiated organs.

PORDES, FRITZ. On the necessity and time for surgical therapy in roentgen irradiated inflammations. *Wien. klin. Wchnschr.*, Apr. 30, 1925, xviii, 487.

The roentgen treatment of inflammations alters the usual picture. Surgical intervention is necessary not only when a fever persists or increases after roentgen treatment, but if any other symptom is accentuated after irradiation (excepting of course the early reactive edema), because such an accentuation indicates the existence of a deep abscess.

An illustrative case of an ulcerating tooth is briefly described. The roentgen treatment given was 3 H, filtered through 4 mm. Al. In about eighteen hours the temperature was down and the pain rather slight, but the edema had increased enormously. An incision drained a few drops of pus and the rest of the symptoms disappeared almost immediately.

PRINZ, R. The roentgen treatment of laryngeal carcinoma. *Beitr. z. klin. Chir.*, 1926, cxxxv, 426–432.

A report is given of 2 cases of histologically identified laryngeal carcinoma treated with roentgen rays. The first patient died five years and seven months of an intercurrent disease after being pronounced cured of the cancer. The second case, in which there was an especially malignant carcinoma with metastases, is alive for over six years since the beginning of her disease, with complete clinical cure and has gone through a pregnancy without signs of a metastatic recurrence. A report is also given of a case of lymphosarcoma which appears to have been cured after two roentgen irradiations.

The roentgen technique in the treatment of the laryngeal carcinoma was as follows: The first irradiation was applied through two fields, 8 by 8 cm., front and back, divided over two days. A 3 cm. paraffin cast was fixed in front, and the back was leveled off even with the skin. The roentgen tubes were placed at a 30 cm. focus-paraffin distance and the rays were filtered through 0.8 mm. Cu plus 2 mm. Al. The tubes were operated at 180 kv., 2.5 ma. to give 90 per cent of the skin unit dose on the back of the neck and 100 per cent in front at the surface of the paraffin. The dose in the region of the tumor was 70 to 80 per cent, calculated from Dessauer's tables. The second series of irradiations was given about nine weeks later over two fields in one day. This time each side of the neck was exposed after building up the front and the side with 6 cm. of paraffin. Each field had a diameter of 10.7 cm. at the surface of the paraffin, the other conditions being the same as above. This treatment gave about 80 per cent of the skin unit dose through the tumor and the gland region.

The third series of irradiations was given five months later. Two fields, 10 by 10 cm. were exposed on both sides of the neck. The central beam was directed upon the affected gland in the left side of the neck. The treatment was given on two days with an interval of a day between. The diameter of the neck was 11 cm., and after building up with paraffin was 25 cm. The focus-paraffin distance was 40 cm. The skin dose to the right and left was 100 per cent, in front 80 per cent and in the larynx and glands 100 per cent of the skin unit dose.

A fourth treatment was given five months later, front and back through a field 12 by 14 cm. Paraffin was used only to give a flat surface. The front to back diameter of the neck in the paraffin was 16 cm. The focus was 40 cm. distant. The dose applied was about 85 per cent to the front, 85 to 90 per cent at the back and about 75 per cent of the skin unit dose at the tumor.

REGAUD, CL. On curietherapy of the epitheliomata of the tongue and of their following adenopathy. *Brit. J. Radiol.*, 1925, xxx, 361–367.

From 1920 to 1923, inclusive, epithelial cancers of the tongue and of the floor of the mouth were treated principally with radium at the Radium Institute of Paris. The total number of cases was 186, the present report being based on 174 of these. At the end of 1924 there were 42 of these cases without any symptoms of cancer. Fifty per cent of the cancers were considered operable and 34 per cent were borderline cases. Thirty-nine had the tongue lesions healed, but they died or are expected to die of the adenopathy. Considering the operable cases alone, the proportion of those in whom the lingual localization was cured either alone or with the glands of the neck, was over 63 per cent.

The other small primary ulcers of the tongue in which the clinical diagnosis is uncertain must be left to surgery. This likewise applies to the failures in radium therapy when they remain operable, because subsequent radium treatments are progressively less efficacious. Roentgen therapy up to the present time has, as a rule, yielded poor results in tongue cancers. On the other hand, cancer of the pharynx responds satisfactorily to roentgen rays. In the much advanced cases palliation is the only

thing to be hoped for. Except for the small primary cases and the far advanced ones, all epitheliomata of the tongue still unirradiated may be treated with radium with reasonable expectation of improvement.

The principles of the author's method of interstitial radium therapy in lingual malignant disease are: To distribute numerous and weak radioactive foci in the whole cancerous part and immediately round it, taking care to create as homogeneous a field of radiation as possible; to use the gamma rays only in order to avoid causing necrosis; to give a continuous irradiation for a long time, thereby keeping down both the intensity and the dose; to attempt success from a single treatment in order to avoid auto-immunization of the neoplasm against the radiations. Radium puncture with platinum needles (with walls 0.5 mm. thick) cutting off all but the gamma rays seems to be superior to the method of burying bare tubes of emanation, and to radium puncture with needles of low filtration. The first method destroys effectively the cancerous mother cells and reduces to a minimum the lesions of the general tissues.

The principal causes of failure from this method of radium puncture are: Too narrow an estimation of the cancerized area; want of accuracy, expecially in places difficult to reach; an insufficient global dose (or too much inequality in the doses delivered by the different needles); needles of imperfect material; radionecrotic accidents. Radionecrosis is a very serious complication and is caused by: an excess of the global dose; excess of the dose in a limited area; repetition of the treatments; inadequate screening; simultaneous association of the radium therapy with a strong irradiation from an external source.

Neither surgery alone nor radiotherapy is able to cure regularly cancerous adenopathies of the neck following epitheliomata of the mouth. The diagnosis of the kind of adenopathy is often impossible without thorough histological examination. The practice of radium puncture of the lymph glands of the neck through the skin, has not yielded satisfactory results; neither has radium-surgery, i.e., placing radioactive material by way of surgical access. The greatest promise of success is offered by the use of radioactive tubes set at a uniform distance of 3 or 4 cm. from the skin over the lymphatic areas. One of the factors that militates against successful radium therapy of cancers of the pars anterodorsalis linguae is the size of the cancerous growth. It is hoped that surgical removal of a block of the tumor may permit the successful application of radium to the residual foci. Until further technical improvement is made in radium therapy of the lymphatic areas of the neck, the author is inclined to favor roentgen therapy in their treatment.

Richarz, Adolf. Retardation in the development of the female breast by roentgen irradiation. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1925, xxxiii, 573–574.

The retardation by means of roentgen rays in the female breast was demonstrated in animal experiments about twenty years ago by Cluzet and Bassal. Two human cases reported in the literature are cited. The third case is reported by the author in the present communication.

The girl at the age of ten was treated for hilus gland tuberculosis, after failure of other methods, with deep irradiations of roentgen rays. She received two treatments over two fields of about 7 by 8 cm., about two-thirds of the skin unit dose through 4 mm. Al (this particular skin unit corresponded to 185 per cent of the skin unit of the Bonn Clinic). This treatment was rather severe and resulted in a mild skin atrophy and pigmentation and both fields are still visible more than five years later. The right mammary gland was exposed in the irradiation while the left was not and pictures of the patient at the age of fifteen show a decided difference in the development of the two mammae. The left is normally developed while the right shows distinct retardation. In other respects the girl appears to be perfectly healthy.

Attention is directed to the fact that retardation in the growth of the mammary gland is produced by roentgen-ray doses that are not large, and care should therefore be taken to avoid this particular danger of roentgen treatment. Experience with this case indicates that a better planning of the irradiations might have averted this damage.

Sahler, Josef. Roentgen irradiation in anuria and oliguria. *Wien. klin. Wchnschr.*, Dec. 10, 1925, xviii, 1330–1333.

A report is given of a case of oliguria followed by anuria in a woman aged twenty-six suffering from gas bacillus infection following abortion. The kidneys became affected and there resulted oliguria and then anuria. Decapsulation of the kidneys was considered, but before attempting this, a trial was made of roentgen irradiation of the kidney. One abdominal and one dorsal field 15 by 15 cm. received 50 per cent of the skin unit dose, and during the next sixteen hours 30 c.c. of urine was voided spontaneously. The general condition was not very much improved and headache

and vomiting continued. On succeeding days the quantity of urine increased and there was a corresponding improvement in the general condition. Within four days the daily volume of urine was 1500 to 1800 c.c. and thereafter remained at this normal level.

Acute and subacute cases of nephritis and nephrosis should be treated with roentgen rays. Chronic and subchronic forms of nephritis with or without uremia may respond to this treatment and it is therefore recommended that it should be attempted wherever possible. The irradiation should be administered immediately upon the first signs of uremia.

SCHÖNHOLZ, LUDWIG. The problem of temporary roentgen castration in the female. *Münchcn. med. Wchnschr.*, May 29, 1925, lxxii, 886–888.

The primary point of attack of the radiation is in the cell nucleus; and irradiation of the unfertilized egg of lower animals has been definitely shown to lead to evidences of malformation in the offspring. For instance, short irradiations of the eggs of butterflies suffice to cause abnormal changes in the growth and fertility of the offspring. Similar evidence of deleterious changes produced by the roentgen rays in lower mammals is considered. In the case of humans it appears that the offspring of a mother who had previously been subjected to temporary castration were apparently normal; but there was an undoubted tendency to abortions in women thus previously treated. The rays apparently act upon the ovary, and in addition there may be some direct effect upon the uterine musculature.

Taking into consideration all the various aspects there is no doubt that the temporary castration of fertile women should be undertaken with the greatest reserve. This temporary castration is justified only as a therapeutic measure to be carried out and recommended in women suffering from gonorrheal or tuberculous involvement of the genital adnexa, cases in which the possibilities of procreation are practically eliminated by the disease itself, and where such a procedure is necessary to retard an infectious process by a temporary inactivation of ovarian activity.

SCHULTE-TIGGES. Technique and dosage in the deep roentgen therapy of pulmonary tuberculosis. *Ztschr. f. Tuberk.*, 1925, xlii, 267–271.

The aim of the technique is to furnish as uniform an irradiation of the lung tissue as possible. One installation used produced radiation with 3 ma., 45 cm. spark gap, which was filtered through 0.5 mm. zinc and 3 mm. aluminum. A reserve installation was operated at 1.8 to 2 ma., and 40 to 42 cm. spark gap, the rays being filtered through 0.5 mm. zinc. The sizes of the fields were as follows: 10 by 10 cm.; 10 by 15 cm.; 15 by 15 cm.; 15 by 20 cm., and 20 by 20 cm. Larger fields were also used for the simultaneous irradiation of both lungs. The focal skin distance was 30 to 50 cm., depending upon the size of the fields.

The doses employed ranged between 20 and 120 R depending upon the site; this corresponds to 3 to 20 per cent of the skin unit dose. A gradual and conservative administration of the dose is recommended. It is wise to begin with small doses, about 20 to 40 R, in order to avoid accidents.

The indications for roentgen treatment are those laid down by Bacmeister: namely, essentially productive, cirrhotic-nodose pulmonary tuberculosis or else essentially nodose cases of stationary or gradual development. Small, well-limited cavities do not constitute contraindications. Treatment should begin with irradiation of an area that is slightly involved. In severe cases it is wise not to select too large fields. Pauses of sufficient duration are of the greatest importance in the outcome. They should last eight to fourteen days longer, and all local general reactions must have receded completely before a further irradiation is given. Inspection of the blood picture, at least in the serious cases, is important. Too great decreases in leucocyte numbers and reduction of the lymphocytes are to be avoided.

The irradiation should embody the principle of cross-fire technique. At the same sitting a frontal irradiation is given, followed immediately by one from the back upon the same lung area. Any decrease in the thickness of the apical fields is to be corrected with boluses of clay. This material absorbs roentgen rays to about the same extent that body tissue does. Wet cellulose, which was previously used for the same purpose, is more inconvenient and disagreeable to the patient.

Three examples of the method of treatment are cited in detail. The results of this treatment are considered to be satisfactory.

SEEFELDER, R. Glioma and roentgen therapy. *Wien. med. Wchnschr.*, Nov. 7, 1925, lxxv, 2498–2501.

A report is given of a case of glioma occurring in a young infant. This was treated by roentgen therapy and apparently began to recede. The other eye had previously been involved, and after an intercurrent infection of the uvea terminated in phthisis bulbi. This was evidently a case of so-called spontaneous

recovery from a glioma, but at the expense of the loss of the eye. The second eye after a roentgen treatment with a total of 30 Holzknecht units delivered in 10 sittings at weekly intervals (radiation of 0.12 Å filtered through 0.36 mm. zinc plus 2 mm. aluminum plus 3 mm. asbestos), showed a very definite recession of the glioma with the formation of white scar tissue. However a recurrence appeared within a few months which gradually increased in rapidity of growth. Repeated roentgen treatments have since had relatively little effect. It would therefore appear that the roentgen treatment of glioma is apparently a hopeless method so far as cure is concerned.

Siedamgrotzky. The roentgen treatment of surgical tuberculosis. *Arch. f. klin. Chir., Berl.*, 1926, cxxxix, 114–123.

An experience with 730 cases of surgical tuberculosis treated by roentgen rays shows that this form of therapy is the method of choice for all form of tuberculous lymphomas, for spina ventosa, as well as for all tuberculous fistulae after operation. In the treatment of the small spongious bones and of small joints, roentgen therapy (without neglect of the usual surgical orthopedic procedures) is an important aid. Tuberculosis of the larger joints is in general unsuited to roentgen therapy but the postoperative irradiation of residual fistulae is promising. The dosage employed both for the gland and bone cases is between 30 to 40 per cent of the skin unit dose, suitable portals of entry being selected according to the location.

The experience at the Charity Hospital, Berlin, is summarized. The average time of observation of the patients was eighteen months and the series of treatments required was 2.1. There were 85 per cent recoveries, 14.5 per cent considerable improvements, and only 0.5 per cent remained unimproved.

When the cases are analyzed from the standpoint of clinical groupings it is found that there was 90.6 per cent recovery in the group of simple hyperplastic glands showing an isolated gland packet, and 86.8 per cent in those with multiple packets. In the group having more or less immobilized glands which showed fluctuation and other signs of breakdown, the percentage cured after roentgen therapy was 71.2. In the last group comprising all the fistulous and polyinfected cases the percentage recovery was 83.7. The roentgen rays exert their effect possibly through the liberation of tuberculin, which elicits a general defense reaction. Certainly experience shows that the roentgen rays elicit not a regenerative response but rather the development of scar tissue.

MISCELLANEOUS

Behnken, H. Steps toward the standardization of measurement of the roentgen dose in Germany. *Strahlentherapie*, 1925, xx, 115–120.

A commission of German roentgenologists and physicists has worked out the following principles which have been accepted by the German Roentgen Society. The absolute unit of roentgen-ray dose is defined as that quantity of roentgen-ray energy which produces one electrostatic unit (measured with a saturation current) when irradiating one cubic centimeter of air at 18°C. and 760 mm. Hg pressure, with complete utilization of the electrons produced in the air, and with exclusion of the effect of the walls of the chamber. The Imperial Physical Technical Institute undertook the problem of establishing the unit dose according to the above definition and made use of the compressed air ionization chamber for this purpose.

By means of the compressed air ionization chamber any roentgen machine may be calibrated in terms of R. In addition to the above institute, there are several other centers in Germany where such calibration can be made.

Since the readings of the practical dosimeter are in general not proportional to those by the standard chamber for various ray qualities there should be, strictly speaking, separate calibration for each ray quality. In practice, however, a limited number of ray qualities will suffice. The ray qualities may be given in terms of the voltage at the roentgen tube and filtration in terms of the semithickness value of copper.

No decision has been made as regards the *biological* unit dose. The skin erythema dose is in general use as a biological unit. Several researches are under way to determine the relation between skin unit dose and R units. The results up to date show that 1200 R = 1 skin unit is a useful average value.

Bioglio, Mario Augusto. Biological and therapeutic action of alpha radium rays. *Arch. di radiol., Naples*, September-October, 1925, i, 713–726.

The ultrapenetrating gamma rays of radium have been used almost exclusively in treatment as it has been thought that the soft rays injure the skin without producing the desired therapeutic effect. But Biolgio and Degrais have often had excellent results in cases which were resistant to ultrapenetrating therapy alone by changing the filtration so that the beta rays also would act on the tumor. It is true that these rays may injure the skin, but the

lesions are curable and there is no doubt of the therapeutic value of the beta rays in many cases. But of the bundle of rays emitted by a radium preparation 92 per cent are alpha rays, 4 per cent beta and 3 per cent gamma. So that if the alpha rays could be utilized it would mean an enormous increase in the efficacy of radium treatment. But as it has been thought impossible to utilize these rays very little attention has been paid to their biological action. The forms of apparatus in use at present do not permit of their use. The tubes and needles in which the radium is contained let only the gamma rays pass.

The author has performed a series of experiments in impregnating leather with radium salts during the process of tanning and dyeing. These preparations emit alpha rays almost exclusively and so are well adapted for studying the qualities of these rays. For alpha rays the weight of the impregnated substance is of less importance than its surface; if a milligram of radium is spread over a large surface it gives a much larger quantity of alpha rays than if confined within a small volume. He found that these pieces of leather were capable of giving a very clear radiographic picture. He found moreover that when a metallic filter was used the image was much clearer, due evidently to the secondary irradiation produced by the metal. These secondary rays have a considerable penetrating power and a photographic action. In spite of the slight penetrating capacity of alpha rays and their ready absorption by the tissues he believes it not impossible that these secondary rays may have a therapeutic action. To prove this of course will require further study of their biological action, and clinical experiments. Seven plates are given showing radiograms obtained by his method.

BORAK, J. Roentgen therapy and organotherapy in endocrine diseases. I. The thyroid gland. *Strahlentherapie*, 1925, xx, 232–267.

It is shown that roentgen rays are capable of producing two contrary effects: (1) they have the property in common with thyroidin of giving rise to the production of a Basedow struma, and (2) they may cause the regression of the struma in cretins. From the smallest to the largest dose, roentgen rays like thyroidin, act in but one direction. The size of the dose determines only the degree but not the direction of the effect. Different doses may produce qualitatively different effects, but these are not due to the mere difference in dosage but because irradiation with larger doses tends to elicit secondary responses that may, depending upon the nature of the disease, overshadow or neutralize the primary roentgen effect. Consequently the eventual response does not depend upon the primary effect of the rays as such, but precisely as in the case of the various effects of thyroidin upon the secondary responses called forth in the surrounding tissues and in the whole organism.

On the other hand, it is a characteristic of the biological effect of radiation in its action on certain organs (to which belong most of the endocrine glands) that the initial and end effects may be opposite in tendency. This reversal is observed usually after the application of rather large doses. The primary effect is a spurt of internal secretion, and later this effect becomes a diminution in production of secretory substance.

A comparison of the clinical results with roentgen therapy in Basedow's disease and organotherapy in myxedema shows a considerable parallelism. The mode of treatment is intermittent except that in myxedema the treatment is chronically intermittent. Under both forms of treatment the primary effect is more rapid the earlier treatment is instituted. The end effect is the same in both except that there is a possibility for permanent cure in Basedow's disease but not in myxedema. In both forms of treatment there is danger of over-dosage.

In Basedow's disease there is hyperfunction of the thyroid, while in myxedema there is hypofunction. In both conditions the functional state of the thyroid is independent of the size of the organ. In Basedow's disease the more exaggerated the functional condition, the smaller is the roentgen-ray dose that can be effectively employed. A stimulating effect is not demonstrated. The effect of the radiation appears sooner in the functioning portion of the cells (protoplasm?) than in the generative (nucleus). The diminution in output of internal secretion may be preceded by an increased output.

In the case of thyroidin treatment in myxedema we find also that the more exaggerated the functional condition, the smaller is the required effective dose. No stimulative effect has been demonstrated. The action appears first in the tissues and only secondarily eventually in the thyroid.

Briefly stated, roentgen rays directly reduce the increased activity of the thyroid, while thyroidin compensates for the reduced thyroid activity directly in the tissues.

CORDUA, RUDOLF. Plasma changes after deep roentgen irradiation. *Strahlentherapie*, 1925, xx, 322–330.

Studies on the blood plasma were made in a series of gynecological cases immediately before

and after deep roentgen therapy. The factors studied were colloidal stability, surface tension and viscosity of the plasma and also the sedimentability of the erythrocytes. There were 17 cases that received roentgen castration; 10 cases of postoperative irradiation of carcinoma; and 14 cases of carcinoma receiving deep roentgen therapy with or without radium. The roentgen rays were administered by an apparatus operated with 2 ma., 40 cm. point-plate spark, the skin unit dose being reached in 45 minutes at 30 cm. distance: corresponding to 830 R. The castration dose was administered through one abdominal and two dorsal fields, the dose in the center of the lower pelvis being about 40 to 45 per cent. In the cases of carcinoma irradiation there were two lateral, two dorsal and one abdominal fields, the dose in the region of the body of the uterus aggregating 90 to 115 per cent of the skin unit dose.

The rate of erythrocyte sedimentation was accelerated in 7 cases, unchanged in 4, and retarded in 4 of the castration cases (in 2 cases the determination was not made). Amongst the carcinoma cases, the sedimentability was increased in 9, unchanged in 4 and retarded in 8 cases. The surface tension of the plasma after irradiation was increased in 5 cases, unchanged in one, and decreased in 9 of the castration cases; and among the carcinoma cases there was increased surface tension in 5, unaltered in 4, and decreased surface tension in 13 cases. The viscosity after irradiation was increased in 11, unchanged in 2 and decreased in 3 of the castration cases; and among the carcinoma cases there were 9 with increased viscosity, one unchanged, and 3 with decreased viscosity after irradiation.

The tests were made on citrated blood plasma obtained either on the day of irradiation or on the second day.

This preliminary study shows that there is no uniform tendency as a result of deep roentgen therapy in the particular characters of the blood plasma that were studied. Attention is directed to the fact that there may be different rates of change involved and that it is necessary to determine the whole reaction curve before the effect can be established or denied.

Dessauer, Fr. On Holthusen's analysis of the heat point hypothesis. *Strahlentherapie*, 1925, xx, 307–321.

Consideration of the nature of the biological effect produced by roentgen rays has led both Dessauer and Holthusen by a process of elimination to conclude that the effect must be of the nature of a photochemical reaction. The analysis did not permit acceptance of the idea that the process was a permanent change in conductivity nor that it was a discharge phenomenon at the surface boundaries of cell membranes.

Dessauer points out that the definitely known photochemical effects due to roentgen-ray absorption are not at all common, but comprise a comparatively few, interesting phenomena.

On the other hand, a response resulting in the production of heat is a practically universal reaction; and energy of the order of 10 to 50 volt-electrons suffices to produce an effect on the largest protein molecules.

In the concept of the production of points of heat which are the effective agent in the roentgenization of living cells, Dessauer does not regard the term heat as an integration of other possible effects under an all-inclusive term. Undoubtedly some aspects of a photochemical process are definitely present but there are other more general effects that are believed to be due to actual transformation of the radiant energy into thermal energy.

Dieterich, W., and Rost, F. The behavior of gastric and intestinal secretion after roentgen irradiation. *Strahlentherapie*, 1925, xx, 108–112.

Is there a change in the acid values and in the enzyme content of the gastric and duodenal secretions following roentgen irradiation of the upper or lower portions of the body, with careful shielding of the stomach and liver regions? Acute roentgen sickness has been often observed in persons after irradiation of the head, and the thought occurred that possibly some change in the gastrointestinal chemism might be discovered.

Experiments were made on two dogs with gastric and duodenal fistulas.

The results of the various tests showed that neither a medium nor a very strong irradiation of the head or of the lower half of the body caused any noteworthy reduction in the acidity or enzymic content of the gastric and duodenal juices. It was observed incidentally that after several weeks there occurred a gradual increase in the acid values and the pepsin content of the gastric juice. Whether this may be regarded as a result of the stimulation of the reontgen rays is left undecided. It was also found that direct irradiation of the stomach with a strong dose does not regularly produce a reduction of the acid and enzyme values in the dog. However, only a few experiments have been made with the direct irradiation of the stomach.

The radiations were produced by a Neo-Intensiv apparatus, with a Coolidge tube, at 180 to 200 kv. (by voltmeter), 130 to 145 kv. (by spectrograph), 2.5 to 3.0 ma., through

0.5 mm. zinc plus 3 mm. aluminum, field 20 × 20 cm., distance 25 to 30 cm. The dose ranged from 41 to 206 per cent of the superficial dose.

DEN HOED, D., and KOOPMAN, L. J. Does the roentgen energy remain constant with variable potential and re-adjustments in the apparatus? *Strahlentherapie*, 1925, XX, 162–180.

With the aid of a Dessauer electroscope or a Seemann spectrograph it is possible to examine a mixture of rays with sufficient accuracy to determine the adequacy of roentgen rays for ordinary roentgenological purposes. The Seemann spectrograph is a very useful instrument for the measurement of potential; and the spectrogram furnishes a picture of the manner in which a roentgen apparatus is functioning. It was found that when a roentgen machine is operated on a primary circuit with a variable potential and adjusted so as to give constant values in the secondary the energy output remained constant within permissible practical limits. Electrical valve tubes have certain advantages over a mechanical rectifier since certain losses in current are eliminated.

Operation of the roentgen machine with condensers offers advantages when working with pulsating direct current. This is brought out by a study of the spectrograms and the photometric data obtained from them.

Certain variations were observed in the biological reaction to roentgen rays at the clinic of the Netherlands Institute for Cancer Research, Amsterdam, and it would appear as a result of the above investigation that such variations were not due to unsteady functioning of the apparatus but apparently to individual differences.

GLOCKER, R., and KAUPP, E. Protection from radiation and the tolerance dose. *Strahlentherapie.*, 1925, XX, 144–152.

In roentgen therapy institutes two forms of radiation protection come into consideration. One is the isolation of the instrument room from the rest of the establishment by means of roentgenopaque material like lead or baryta walls. The second is the complete enclosure of the roentgen tube in order to make the zone of possible roentgen-ray danger as small as possible, with provision for controlled escape of the necessary roentgen energy for the desired purposes.

A description is given of the Siemens irradiation chamber. This is fixed to the wall of the treatment room and the position of the patient is adjusted. The question as to the degree to which such a device is "safe" depends (1) on the magnitude of the secondary radiations produced in the irradiated body, and (2) on the total quantity of roentgen-ray energy that a busy roentgenologist can tolerate without injury (the tolerance dose) in a given period. Measurements with the water phantom show that a completely inclosed roentgen tube such as described above produces at a height of one meter from the floor and a distance of $1\frac{3}{4}$ meters from the irradiated body a secondary radiation capable of giving in 1000 hours a dose equal to the skin unit dose.

According to Mutscheller the dose which may be continuously tolerated without injury in the course of a month (approximately 200 working hours) is about $^1/_{100}$ of the skin unit dose. This gives a tolerance dose per hour of work of $^1/_{20.000}$ of the skin unit dose. According to the above measurements the dose received from scattered radiation depending on the position, is $^1/_{1000}$ to $^1/_{8000}$ of the skin unit dose per hour. This is decidedly greater than the tolerance dose. This conclusion therefore shows that the completely inclosed roentgen tube does not suffice to render all portions of the therapy room safe for necessary attendants. This danger is greatest to either side of the patient and is least in the direction of the axis of his or her body. It is recommended that the treatment table be covered with a layer of 3 mm. of lead and that the side of the table toward the roentgenologist or attendant have a vertical wall of 3 mm. lead about 25 cm. high.

Tests should be made with the aid of a fluorescent screen and with well-adapted eyes to see if and in what directions primary roentgen rays escape from the housing of the roentgen tube. The lower limit of visibility of therapy rays with an Astral screen corresponds approximately to the amount of roentgen rays which can be continuously tolerated without injury by roentgenologists and attendants. It is however a wise thing to conclude that any portion of the treatment room in which fluorescence can be demonstrated upon the screen is no safe place for continuous work by any individual.

GLASSER, OTTO. Erythema doses in roentgen units. *Strahlentherapie*, 1925, XX, 141–143.

Reports from different workers give the erythema dose anywhere between 200 and 2000 R units. It is not certain at present how much of this divergence is to be ascribed to inadequate definition of the units employed, to erroneous interpretation in practice, and to differences in biological reaction. It is therefore of value at the present time to report on exact measurements of biological dose in R units so that the data from various laboratories may ultimately be collected and compared.

During the past two years 50 newly installed roentgen machines of different makes and set up in different cities in North America were standardized in terms of electrostatic or R units and compared. An improved Dessauer electroscope was used for making inter-comparisons between the 50 different roentgen machines, and many thousands of patients were used in establishing the biological reaction.

The milliampere-minutes required to produce 1400 R (the erythema dose produced by one machine) varied greatly, between 280 and 650 ma-min., for different types of apparatus. It was found in about 75 per cent of the observed cases that a single dose of 1400 R over the abdomen produced an erythema of the first degree; 1600 R is required when the dose is distributed over a period of two weeks. An application of one dose approximately 10 per cent smaller resulted in no skin reaction in practically all cases.

In about 20 per cent of those cases that showed no skin reaction when 1400 R was applied in one dose this reaction was made to appear when the dose was increased about 10 per cent. The remaining 5 per cent of the cases responded with a second degree erythema to a single dose of 1400 R. In this group a reduction of the dose by 15 per cent produced the desired erythema of the first degree.

Those cases that responded with a first degree erythema to a dose of 1400 R gave a distinct reaction of the second degree when the dose was increased about 20 per cent. A reaction of the third degree with swelling of the follicles and blistering was intentionally produced in certain cases and this required about 2000 R.

Grebe, L., and Martius, H. The measurement of roentgen rays in absolute terms and the quantity of roentgen rays necessary to produce a skin erythema. *Strahlentherapie*, 1925, xx, 128–140.

Attention is directed to the fact that there are in the literature two different units designated as R. The unit proposed by Behnken is in terms of electrostatic units and is reliable and reproducible. The unit proposed by Solomon based on the activity of radium under certain conditions is difficult to reproduce except in instruments of identical construction. Comparative measurements with the compressed air ionization chamber, the 25 cm. and 10 cm. chambers at atmospheric pressure, were found to yield the same results within the error of observation. It would seem therefore that for calibration of roentgen instruments in practice the complicated arrangement employing the compressed air ionization chamber is not absolutely essential.

Friedrich and Krönig report the skin unit dose to be about 170 R; the authors find 600 R; on the other hand, amongst American observers, Duane gives the erythema dose as 1800 R, and Fricke and Glasser about 1400 R. This discrepancy is explained as being due to the fact that the German observers measure the energy in the primary beam of radiation, while American observers include in their measurement the recoil radiation at the surface. Direct experiment shows that the dose measured in the primary beam should be increased by 60 to 100 per cent if account is to be taken of the secondary radiation. Considering the fact that a skin erythema as criterion of dosage varies more or less between observers, the above suggested correction brings into fair agreement the apparently contradictory observations noted.

As has been stated, an average value of 600 R as measured in the incident beam of roentgen rays has been found by the authors to represent a skin unit dose which can be applied to the skin without danger. If there is added to this value the amount of secondary radiation produced in a 15×20 cm. field the total value for the mean erythema dose is 1200 R for the ray qualities that are ordinarily employed in deep therapy. This value is suggested as a useful average erythema or skin unit dose for roentgen therapy.

Hallheimer, S., and Schinz, H. R. The effect of roentgen rays on the indophenolblue-oxidases in tissue and in leucocytes. *Strahlentherapie*, 1925, xx, 331–341.

Examinations of leucocytes, skin, and skeletal, diaphragmatic and cardiac musculature show no alterations in the stable or labile oxidases as a direct result of exposure to roentgen rays. Such staining differences as are observed are found to be due to variations in the thickness of sections, and can be found in unexposed as well as exposed tissues, *in vitro* and *in vivo*. This confirms the conclusions of those observers who state that roentgen rays probably do not produce their effect on the oxidation mechanism, i.e., functional metabolism, of the cell.

Differences in oxidation of irradiated and non-irradiated cells a long time after treatment must be regarded as secondary effects. So far as can be determined the labile and stable cell tissue oxidases are primarily resistant to the rays.

The above conclusions are based on experiments made upon guinea pigs. The various tissues were removed immediately after death and exposed for about an hour to rays produced by 2.5 ma., with a parallel spark gap (point to

point) of about 24 cm.; no filter, distance 23 cm. The dose was about 600 per cent of the skin erythema dose or about 36,000 R. There were also parallel *in vivo* experiments where the guinea pigs received the same radiation for one and two hours. The indophenol reaction was carried out according to the procedure of Gräff. The alpha-naphthol and di-methyl paraphenylene diamine solutions were mixed with phosphate buffer so as to give a final mixture having a pH of 8.1. Frozen sections of the tissues were immersed in the above reagent for five to thirty minutes and then examined for the characteristic granules.

KLÖVEKORN, H. The action of roentgen rays on bacteria. *Strahlentherapie*, 1925, xx, 354–377.

The results of previous investigations have varied considerably in that some authors believe there is a good bactericidal action, others note a stimulative effect and still others observe certain biological alterations. These great variations are due to many factors such as non-uniformity in the methods of measuring the dose, differences in the quantities and bualities of radiations employed, differences between microorganisms, culture media, etc. A list of 58 references is appended and the various contributions are critically analyzed. Experiments were also conducted upon the bactericidal and retardative action of roentgen rays upon *Bacterium coli* and *Staphylococcus aureus*. Freshly growing cultures of these organisms upon agar were not killed after exposure to a dose of 120 Sabouraud-Noiré (1 S. N. = 600 R). The same was found for broth cultures and saline suspensions of cultures twenty-four hours old. With doses of 70 S.N. and upward the colonies growing on agar plates exhibit biological changes such as pigment loss and irregularities in the colony outlines, as well as inhibition in growth.

By a refinement in technique it was definitely shown that this growth inhibition was produced by doses from 60 down to 20 S.N. The diminution in inhibition went parallel with the decrease in dose of rays. Killing of the staphylococci and colon bacilli was obtained only with old cultures, about twenty-eight to thirty days old and more, and with a dose of 110 to 120 S.N.

KOLODNY, ANATOLE. The relation of the bone marrow to the lymphatic system. *Arch. Surg.*, November, 1925, xi, 690–707.

The bone marrow is directly related to the lymphatic system. It drains its lymph into certain groups of lymph nodes, the regional lymph nodes of the respective bone. The regional lymph nodes of the bones of the upper extremity are the cervical lymph nodes in dogs, corresponding to the supraclavicular lymph nodes in man. The regional lymph nodes of the bones of the lower extremity are the iliac lymph nodes in dogs corresponding to the external chain of the external iliac group and the hypogastric lymph nodes in man.

The direct relationship existing between the bone marrow and the lymphatic system forms the anatomic basis for the lymphogenous theory of metastasizing of carcinomatous tumors to the bones.

Deviations from the normal in the flow of lymph, namely, the aberration of the lymph stream, the retrograde lymph stream and the reflux lymph flow, can lead to the metastatic spread through the skeleton of carcinomatous cells transported in the lymph circulation from the primary tumor.

KÜSTNER, H. The Göttingen laboratory for medical physics, and the standard calibrations. *Strahlentherapie*, 1925, xx, 121–127.

A description is given of the installation which is used in calibrating roentgen machines in terms of the German standard R unit. A brief description is also given of the portable apparatus for standardization purposes. The portable instrument makes use of a Wulf two-string electrometer directly connected to a carbon thimble ionization chamber. The whole is inclosed in a lead box with walls 5 mm. thick, except for two small windows covered by celluloid. These precautions protect the instrument from changes in capacity. A potentiometer arrangement is employed for maintaining constancy in the potential sensitivity.

The advantage of these portable machines is that when returned to the standard laboratory they may be checked against the laboratory instruments to determine any alterations in sensitivity. The laboratory standard should be calibrated against either a gamma ray or an alpha ray preparation.

LUDWIG, FRITZ, and HOPF, HERMANN. Experimental studies on the effect of roentgen rays upon food. *Strahlentherapie*, 1925, xx, 342–353.

Experiments were conducted to determine the effect of the roentgen treatment of food upon animals. One series of animals received irradiated food and a control series received the same food unirradiated. It was discovered incidentally that wild mice having access to the two lots of food (wheat) ate the control lot but left undisturbed the irradiated wheat. There was evidently something in the irradi-

ated food which was recognized at once by the wild mice.

The food was irradiated uniformly in layers 6 cm. deep with about 20 X, through 1 mm. Al, very hard radiation, 220 kv. Animals receiving this diet succumbed in sixty to ninety days. Another lot of food was irradiated in layers about 15 cm. deep and the animals fed with this material did not succumb until after 130 days of this dietary regime.

The first experiment was conducted upon white mice, 50 animals being used for experiment and 50 for control. The experimental animals began to die off in the sixth week and all died by the twelfth week, whereas 47 of the controls were still alive at the end of the experiment. The diet consisted of irradiated carrots and irradiated bread moistened with unirradiated water, plus some irradiated wheat which had been softened in ordinary water.

Other experiments were performed on young white rats from the same litter. The results were essentially the same. The experimental animals followed practically the same growth curve as the controls for a greater or shorter period and then dropped rapidly in weight until death supervened.

The animals receiving the roentgenized diet showed disease symptoms rather early as evidenced by loss of appetite and sluggish activity. The fur became very much roughened and some of the hair fell out. Palpation of the bones seemed to cause the animals pain. Movement became more difficult and dragging, and the legs appeared hardly able to support the body. In this stage the bones felt quite soft to the touch. The teeth likewise became more brittle so that they could be easily broken off.

Roentgenograms of some of these animals showed a very marked bending of the spine. There was also a distinct cartilaginous thickening at the costochondral junctions giving a distinct picture of rachitic beading. Marked loss of calcium was evident in the ribs and at the ends of the long tubular bones; decalcification and swelling were very pronounced especially at the lower ends of the radius and ulna. The upper end of the tibia showed swelling, and decalcification was likewise very distinct; the epiphyseal line was a light, broad irregularly decalcified zone which in the normal animal is seen as a very narrow line.

The results show quite distinctly that roentgen rays produce a direct effect upon food. This effect is either one of destruction of vital elements or the production of toxic products. Continued feeding of roentgenized food causes death in experimental animals. Possibly by the feeding of roentgenized food changes are produced in the animal body similar to those produced by direct irradiation of the experimental animals. If this be true, then one can assume an indirect transfer of the roentgen-ray effect in the food.

MACLEAN, NEIL JOHN. Observations on the treatment of goiter. *Illinois M. J.*, May, 1925 xlvii, 354–358.

Treatment of simple goiter during childhood and adolescence is medical. Attention should be given to personal hygiene, removal of infective foci and the administration of iodine. After the age of twenty, iodine should not be administered except in minute doses such as are used in prophylaxis. The indiscriminate use of iodine cannot be too severely condemned. A simple goiter in a patient over twenty-five years old is usually permanent and if causing local or toxic symptoms or is unsightly it should be removed surgically.

In toxic goiter the treatment is positively surgical. Operation during the acutely toxic stage is, however, attended with great danger. Speaking in a general way, operation in these toxic goiters can and should be fairly complete.

The treatment of exophthalmic goiter (Graves' disease) is one of the most difficult of medical problems calling for the combined cooperation of family physician, internist and surgeon. At the present time the only adequate treatment is surgical, but the one disquieting feature is the high collective operative mortality. In 1921 the author wrote to 100 hospitals in the United States and Canada for their statistics on goiter and found that the operative mortality for exophthalmic goiter averaged 8 per cent. Recently the author wrote to 200 more hospitals and the combined statistics from 70 of these hospitals for the two years 1922–1923 were as follows:

	Cases Number	Operative Mortality	Percentage
1. Simple goiter (non-toxic)	1403	10	0.7
2. Toxic goiter	1352	35	2.6
3. Exophthalmic goiter	1116	80	7.2